FIRST ANNUAL REPORT

OF THE

STATE

AGRICULTURAL EXPERIMENT STATION,

AT

AMHERST. MASS.

1883.

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AGRICULTURAL EXPERIMENT STATION,

AT AMHERST, MASS.

BOARD OF CONTROL, 1883.

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Governor of the Commonwealth, President ex officio.

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James R. Nichols, ... Haverhill.
Members of the State Board of Agriculture.

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J. H. Demond, ... Northampton.
Members of the Board of Trustees of the Mass. Agricultural College.

Theodore Lyman, ... Brookline,
Member of the Massachusetts Society for Promoting Agriculture.

James C. Greenough, ... Amherst.
President of the Massachusetts Agricultural College.

OFFICERS APPOINTED BY THE BOARD OF CONTROL.

C. A. Goessmann, Prof. of Chemistry at the Mass. Agricultural College.
Director and Chemist.

M. Miles, Prof. of Agriculture at the Mass. Agricultural College.
Supt. of Field and Stock Experiments.

S. T. Maynard, Prof. of Botany at the Mass. Agricultural College.
Supt. of Horticultural Experiments, Microscopist and Draughtsman.

To the Secretary of the State Board of Agriculture.

SIR: — I herewith transmit to you for the approval of the Board and publication in your report to the Senate and House of Representatives the reports made by the officers of the Agricultural Experiment Station to the Board of Control.

O. B. HADWEN,
Secretary.

ANNUAL REPORT

OF THE

DIRECTOR OF THE STATE AGRICULTURAL EXPERIMENT STATION AT AMHERST, MASS.

To the Honorable Board of Control.

GENTLEMEN:— I have the honor to present herewith respectfully the Annual Reports.

The real estate rented from the trustees of the Massachusetts Agricultural College consists of one dwelling house for offices and collection rooms, one barn with stables for stock-feeding experiments, and nineteen acres of land for field experiments. A few rooms set apart in the chemical department of the college serve as a laboratory for the execution of the chemical work of the station. The reconstruction of the buildings accepted by the Board has been devised and conducted by the committee appointed for that purpose; namely, the President of the college and Mr. Hadwen. The refitting of the barn and stables for stock-feeding experiments has been under the personal supervision of Professor M. Miles, and in the main according to plans of his submitted for consideration to the committee on buildings. A detailed description of this work, with illustrations, will be found in his report to the Secretary of the Board. The supervision of the field work has been divided between Prof. Miles and Prof. Maynard. To the former has been assigned sixteen acres in the vicinity of the farm buildings of the station; to the latter three acres near the plant-house in the botanical department of the college.

The field work of the station during its first year of active operations has been in several directions, and for obvious reasons of a preparatory character.

As the lands secured from the college consisted largely of grass land, of some pieces of winter grain — wheat — and

the experimental plats of the former for studying the growth of a variety of fruit and forage plants, it seemed for economical reasons best to secure the crops for the payment of the rents, and to prepare additional plats for field experiments, with reference to the limited financial resources at the disposal of the Board. Two and two-tenths acres of corn — in part for ensilage — and about one and one-half acres of a series of prominent forage crops, leguminous plants in particular, for comparative analysis regarding their relative feeding value, comprise the produce of the newly-arranged plats. A description of eleven underdrained plats, with an illustration of the entire work of underdraining, and of grading in a certain section of the farm land, and near the buildings designed for experimental work, will be found in the above stated report of Prof. Miles.

The same report contains the details of the cultivation of the corn, and of the filling of the silo, and of a feeding experiment with pigs, accompanied by the views of Prof. Miles regarding these matters.

The experiments concerning the effect of special mineral manures on the growth of fruit-bearing plants, and the character of the fruits produced by their assistance, which were inaugurated about ten years ago, have been continued for the past year. Two additional experimental plats of land were secured for the cultivation of fruit-trees, with the aid of the muriate of potash and the sulphate of potash, for the purpose of ascertaining their respective effect, in the interest of economy.

The cultivation of forage crops has received considerable attention, new varieties having been added to those cultivated in previous years. Collections at different stages of growth have been made, to ascertain their respective nutritive value. A description of the field work in connection with these experiments will be found in the appended report of Prof. S. T. Maynard, in whose particular care the lands occupied by small fruits, fruit trees and forage crops above referred to, have been during past years. Prof. Maynard's report contains also his experiments regarding the destruction of injurious insects and of fungi growth. His examination regarding the adulteration of field and garden seeds,

besides his inquiries concerning the best means for the destruction of the seeds of weeds, is fairly under way, and reports of the progress in these matters may soon be expected in the periodical publications of the Station.

The investigations concerning the characteristics of the "*fire worm*," the pest of the cranberry, with a view of ascertaining the means for its destruction, which, by a vote of the State Board of Agriculture, had been referred to the Station, has received a careful and generous attention, at my invitation, by Prof. W. S. Stearns, an entomologist by protession. The results of his work have been presented, in an able paper, at the late country meeting of the State Board of Agriculture, at Lowell.

The chemical department has been engaged to the full extent of its means. Most of its work has been already published in six monthly bulletins.

The analytical examinations comprise a series of articles sent on for that purpose by farmers' clubs; leading agricultural chemicals and other commercial manurial substances, not under control of the fertilizer laws; a variety of refuse material for the manufacture of home-made fertilizers; important commercial fodder substances, and leading farm crops.

The details of these investigations form the principal portion of the report of the chemist. This report contains also some statements regarding previous examinations, which have not been published in full in any State report, and, judging from frequent inquiries received, will prove of interest to some of the friends of progressive agriculture.

It has been the aim, in the management of the work of the Station, to meet promptly the direct applications of farmers' clubs, and the temporary wants of the farming community, and to prepare, as fast as circumstances enabled, and the thoroughness of the future work admitted, for experiments in field and barn.

Much work has been accomplished in both directions. Analyses of the drainage waters of the underdrained experimental plats, and of the crops raised upon the latter, as well as those raised on the remaining fields of the station, have been made, to serve as a basis for field and feeding experi-

ments during the coming season. The stables for feeding experiments are finished on a general plan, and require but limited expense and time to be fitted for special experiments in stock-feeding.

A considerable amount and variety of fodder raised upon the fields of the Station is on hand, to serve, in connection with the silo product, for feeding experiments.

Want of time and of means have thus far prevented the entering upon a systematic observation of the weather and the relation of the atmosphere on the physical and chemical condition of the soil. The observations which have been made in this direction are consequently rather fragmentary, and will be retained for the present, to be published when properly supplemented. One of the principal wants in the present stage of the Experiment Station consists in suitable rooms fit for careful observations of various kinds in agricultural chemistry and physics. The space at present occupied by the chemist consists of two rooms for general analytical work, for which they are well adapted. The remainder of the building, known by the name of "Chapel building," is occupied for various purposes by the college, and is decidedly inadequate to its daily-increasing wants. No more room can be obtained from the college authorities, nor can the restoration of the two rooms occupied by the Station meet the wants of the college. As the gas works of the Experiment Station are in connection with its present laboratory, and the building very suitable for the immediate wants of the experiments, as far as additional buildings are concerned, it seems, in the interest of economy, advisable to induce the college authorities to assign the entire building to the use of the Station, at a liberal rent; and to meet their wants by the erection of a new building, which they will be obliged to do at an early date. The best interests of both State institutions will be benefited by such an arrangement, which is presented for your careful consideration.

C. A. GOESSMANN,
Director.

REPORT OF SUPERINTENDENT

OF

FIELD AND FEEDING EXPERIMENTS.

To the Honorable the Board of Control oj
The State Agricultural Experiment Station.

The following report ot operations in the department ol Field and Feeding Experiments for the year 1883 is respectfully submitted.

M. MILES,
Superintendent of Field and Feeding Experiments.

At the beginning of the present year an outline of a plan of experiments, in this department, was drawn up by me for the consideration of the Board, together with a plan for the required alterations in the old barn to fit it for the purposes of feeding experiments, and presented to Director Goessmann.

Having been informed that this plan of proposed experiments had been approved by the Board of Control, I was instructed by the Director of the Station to locate and stake out the proposed plats for the field experiments, and to construct the required drains, with provisions for collecting the drainage waters, to carry out the systematic investigations contemplated in the outline presented under the first subdivision of the approved plan.

The Field Plats.

After a careful examination of the area assigned for field experiments and a detailed study of its previous history as to cropping, with reference to its present agricultural condition, — in which I was materially aided by the advice and suggestions that were kindly given by Hon. Levi Stockbridge,

ex-president of the Agricultural College, — two series of plats were selected that presented the required conditions of uniformity and surface soil and exposure.

When the trenches for laying the tiles had been dug, it was likewise found that the subsoil in each series of plats was quite as uniform in its characteristics as the surface soil.

Through the liberality of Mr. W. W. Hunt of Amherst, who volunteered to furnish the tiles at actual cost, the Station had the benefit in their purchase of strictly wholesale rates.

The arrangement of the plats and the location of the drains will be readily understood by reference to the plan, in the supplementary paper, marked "Exhibit B."

The plats are two rods wide and eight rods long, giving an area of one-tenth of an acre each. To prevent any confusion as to locality, when referring to a particular plat, the east series of plats are designated by odd numbers, and the west series by even numbers.

The dotted line on the plan marks the boundary of an area that was cultivated as a vegetable garden for several years. From the heavy applications of manure that had formerly been made to this garden patch, the west series of plats should only be used for rotation experiments, which should be made to ascertain the influence of one crop upon the growth of another, and the influence of the system of cropping in conserving the elements of fertility, and upon the loss of fertilizing materials by drainage.

The east tier of plats (with odd numbers) have been under ordinary field culture, and for several years past in grass, which is badly "run out," the hay having been removed without the return of an equivalent in the form of manure; so that their present condition, as represented by their past history, is well adapted to the proposed permanent experiments with corn.

Drains.

A main drain of round tiles laid four feet deep has been made along the east side of each series of plats (four feet from the line of plats), with wells of sewer pipe opposite the middle of each plat, for the purpose of collecting samples of the drainage waters from the lateral drains which open

into them. The size of the tiles in the main drain is marked in red ink on the plan.

The laterals, of two-inch round tiles, are laid through the middle of each plat, and have their outlet in the wells twelve inches above the grade of the main drain.

From the great practical, as well as theoretical, importance of the experiments with drainage waters, extraordinary care has been taken in laying all of the tiles in the system of drainage, the slope or fall being the same in all cases to secure uniformity in their action, and to prevent the formation of pools of stagnant water within the range of the tiles to modify the composition of the drainage waters when the drains are running.

Culvert.

To secure an outlet for the main drain it was necessary to make a deep cut across the roadway on the south line of the experimental field, and make a new culvert to provide for the surface-drainage in the spring. This culvert is made of six-inch sewer pipe, resting on a wall of stones laid in cement to a depth of four feet below the line of pipes, to prevent the displacement of the sewer pipe by frost. A similar culvert was also made across the roadway on the north line of the experimental field.

In the construction of the main drains many large boulders were encountered in the lower twelve inches of the trench, which, together with the compactness of the clay and imbedded gravel, materially increased the cost of the work.

The work of digging trenches for the tile drains was begun April 16th, and the laterals on the east tier of plats were completed May 10th. From a delay in obtaining sewer pipe, the wells were not finished until some time afterwards.

Corn Experiments.

An account of the experimental crop of corn grown on the east series of plats, together with observations made on the drainage waters, will be found in the paper marked B, accompanying this report.

Drainage of Buildings.

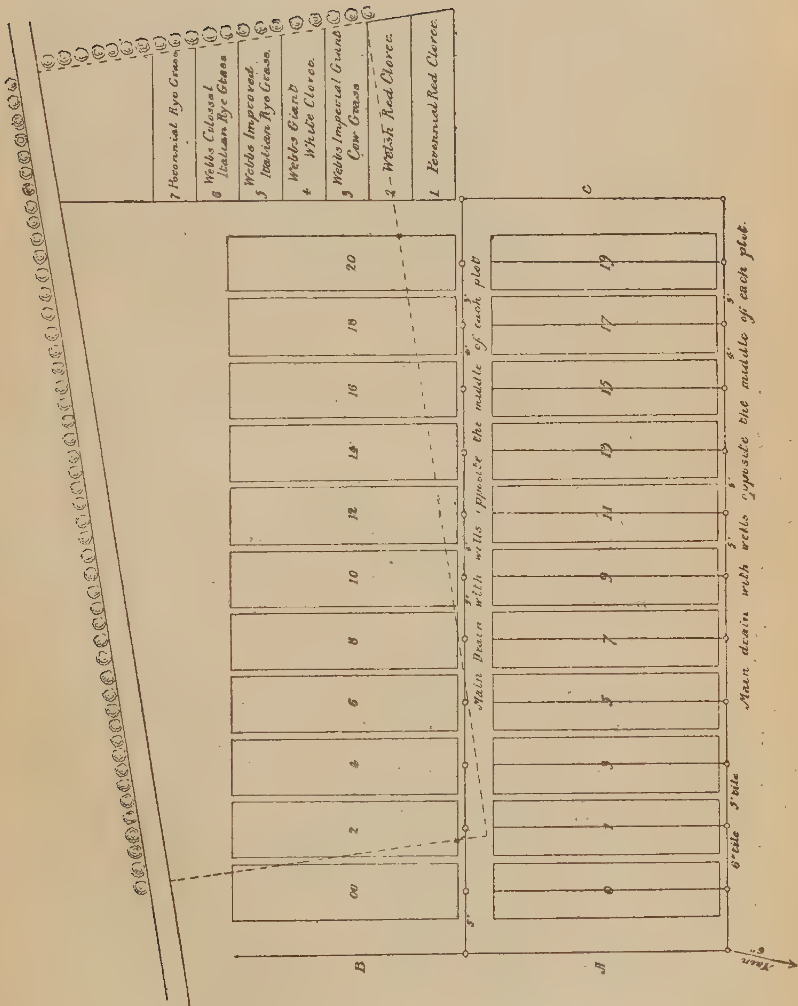
After every heavy rain in the spring the floor of the box stalls, the scale pit in the barn, and the cellar of the house, were flooded with water — the soil in the vicinity of the buildings being completely saturated, almost to the surface.

On the 6th of May I presented to Director Goessmann a report of expenditures made by me in the work under my charge, together with estimates and recommendations in regard to the drainage of the buildings.

The construction of this system of drains having been authorized by the Board of Control, the work was begun by securing an outlet, by a junction with the main drain of the experimental plats, where it crosses the road on the south line of the experimental farm.

As a matter of economy, I can only repeat the recommendation made in the report of May 6th: that a six-inch tile should be laid from the culvert, where the present main has its outlet, to the small stream running across the farm, in order to secure a permanent outlet for the system of drains on the experiment farm.

In laying the main for the drainage of the buildings the same difficulties were encountered as in the case of the mains of the experiment plats, with the additional disadvantage of running water in the trenches, notwithstanding the work was done later in the season. A plan of these drains, showing their relation to the buildings, is given on the following page: —


7 Perennial Rye Grass
6 Webbs Colossal Italian Rye Grass
5 Webbs Improved Italian Rye Grass
4 Webbs Giant White Clover
3 Webbs Imperial Giant Cow Grass
2 – Welsh Red Clover
1 Perennial Red Clover
C
20
18
16
14
12
10
8
6
4
2
00
19
17
15
13
11
9
7
5
3
1
0
Main Drain with wells opposite the middle of each plot
Main drain with wells opposite the middle of each plot.
5" tile
6" tile
Main 6"
B
B

Forage Crops.

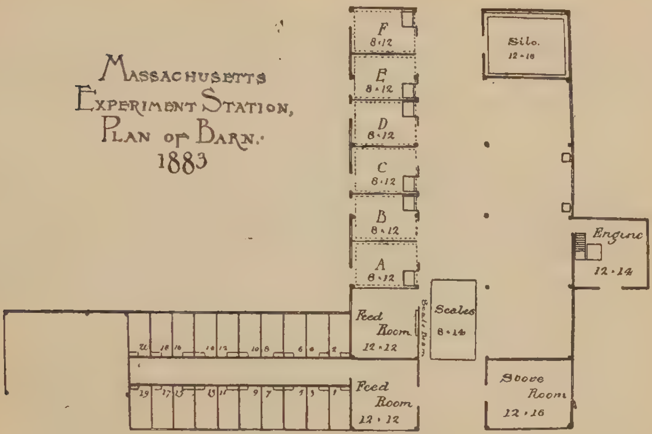
With the approval of Director Goessmann, I ordered from England some seeds of forage crops, that seemed to be worthy of trial, which have been sowed on a series of plats just north of the plats heretofore described. From delays in transportation and detention in the custom house, the seeds were not sown until June 6th, the beginning of the dry season. Notwithstanding the unfavorable conditions of growth, the plants appear to be fairly well rooted, and the results for next summer will be looked for with interest. The varieties of seeds sown are marked on the plan of plats given in the report on corn experiments, marked "Exhibit B," as follows: —

1. Perennial Red Clover.
2. Welsh Red Clover, claimed to be "well adapted to land at all clover-sick."
3. Imperial Giant Cow Grass.
4. Giant Perennial White Clover.
5. Webb's Improved Italian Rye Grass.
6. Webb's Colossal Italian Rye Grass.
7. Perennial Rye Grass.

Feeding Barn.

The feeding barn was repaired and reconstructed, under my personal supervision, in accordance with the plan approved by the Board of Control, and under the advice and direction, from time to time, of Mr. O. B. Hadwen and Director Goessmann of the Building Committee. It is arranged with six box-stalls with cement floors, for feeding cattle and valuing manure, and twenty pens for feeding pigs and other small animals. There is also a silo, an engine-room, and feed-rooms, with convenient fittings for experiments.

The ground floor of the barn is given in outline on the following plan: —



The scales, manufactured to order with both metric and United States standard weights, were furnished by Fairbanks, Brown & Co. of Boston, at a very liberal discount from current rates.

Experiments.

When the barn was completed I was officially notified that the feeding experiments would be confined to the feeding of ensilage, and I was directed to superintend the construction of a silo to prepare for that work.

A description of the silo and the progress that has been made in the experiments with ensilage will be found in detail in the paper presented herewith, marked "Exhibit E."

The results thus far obtained are of great practical interest, as they seem to indicate the conditions that must be observed in preserving green crops in the form of ensilage, in order to secure a reasonable certainty in the results and a desirable uniformity in the quality of the product.

My opportunities for experimental work have been exceedingly limited, from the fact that most of my time has been spent in the personal supervision of the improvements in progress in the experiment field and in and around the buildings, as in the laying out of plats, the construction of drains, grading of the grounds, and making drive ways, etc., etc.

With the aid of my assistant, the work of making feed-bins, racks for drying experimental crops, fittings for pens and boxes, and other appliances for the purpose of experimentation, has been done in the intervals of other duties.

Hay.

The hay of the experimental farm was turned over to the college farm by Director Goessmann, with the exception of the produce of certain areas, which I was requested to select for experiments in feeding, which is stored in the feeding-barn on the upper floor

Grounds.

The grounds around the building have been graded and seeded with a mixture of lawn grasses, and the road-bed of the carriage way in front of the buildings has been filled with stones and partly covered with gravel.

Pig Feeding.

Permission having been given me to " make any experiments that did not involve expense to the station," ten Berkshire pigs were placed in the pens October 18 and fed until December 17. The details and result of this experiment are herewith presented in the paper marked " Exhibit F."

In the supplementary papers presented with this report approximate estimates have been made of the additional facilities that are required in this department to carry on the work in a satisfactory manner.

Massachusetts Experiment Station,
Department of Field and Feeding Experiments,
Amherst, Dec. 22, 1883.

[Exhibit B.]

CORN EXPERIMENTS AND DRAINAGE.

Experiments with Indian Corn.

In accordance with the plan of experiments, approved by the Board of Control in January, corn was grown on the east series of plats (designated on the plan by odd numbers), without manure, and under the same conditions as to management, for the purpose of testing the relative fertility of the plats.

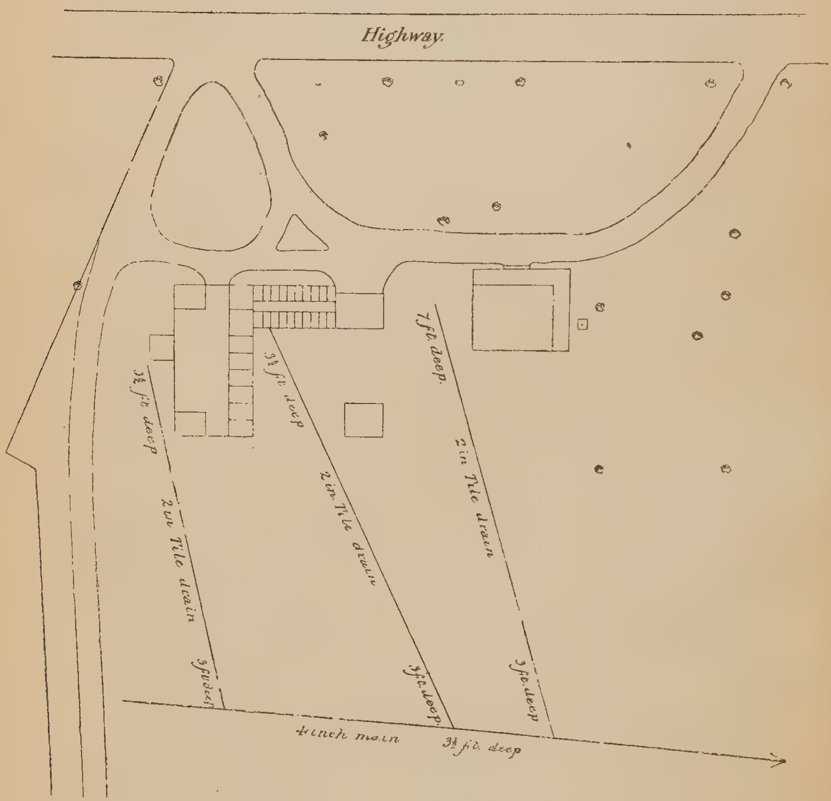
The arrangement of the plats and an outline of the drains are given on the accompanying plan. The plats, of one-tenth of an acre each, are two rods wide and eight rods long, and they are separated by a space four feet wide, on which no crop is grown.

The soil is a friable loam, with a retentive subsoil of clay that is nearly filled with gravel and small stones in the lower strata.

There is a remarkable uniformity in the soil and subsoil of the different plats, both as to apparent fertility and physical condition, with the exception of plat 0, where a large manure pile had formerly been made.

When the plats were laid out, it was readily seen, from the luxuriant growth of grass on plat 0, that it would not be comparable with the other plats under any conditions, but it was finally staked out, and added to the series as an extra plat, as it furnished the opportunity for studying the drainage waters of a soil highly manured.

In all operations of ploughing, cultivating, planting, hoeing and harvesting, the work was done lengthwise of the field, and consequently across the plats, so that each plat received the same treatment, as far as possible, both as to the amount of labor expended and the time in which it was performed.


Highway.
3½ ft. deep
2 in Tile drain
3 ft. deep
3½ ft. deep
2 in. Tile drain
3 ft. deep.
7 ft. deep.
2 in Tile drain
3 ft. deep
4 inch main
3½ ft. deep

The plats were ploughed May 14, but from the heavy rains that soon followed, which are noticed in the account of the drainage, the after-cultivation was delayed until May 25, and the corn was not planted until a week later.

"Longfellow corn" was planted June 2, in hills, forty-four inches apart each way. The soil was in fine condition, and the plants came up evenly on the 8th inst., looking healthy and vigorous.

As the first and second days of June were the first really warm days of the season, the late planting did not at the time seem to be a serious disadvantage.

The cultivation of the crops was as follows: Cultivated, June 15; hand hoed, June 18; thinned to four plants in a hill, June 21; cultivated and hoed, without hilling, June 26, July 9 and 25; and a final hoeing, which was limited to killing the weeds that had survived the previous treatment, was given August 2.

The plats were quite free from weeds on the start, and the repeated cultivation and hoeing left the crop perfectly clean in its subsequent growth.

On the night of September 3 a hard frost severely injured the corn, and it should have been cut up the following day; but as we were dependent on the farm for labor, we were obliged to wait until the 7th inst., when the crop was cut close to the ground and put in stooks to cure. The leaves were considerably "wilted," but the stooks were not apparently injured.

The corn was husked October 18 by the "juniors," who volunteered their services, so that all the plats could be husked in one day. The corn and stalks were hauled to the barn and separately weighed, but the corn from plats fifteen, seventeen and nineteen was not weighed until the next morning. In Table I. the weight of corn and stalks is given for each plat: —

TABLE I.

PLATS.	No. of missing hills.	Sound Corn, lbs.	Soft Corn. Lbs.	Total Corn.	Stalks. Lbs.
0, ...	0	224.5	101.5	326.	578
1, ...	3	90.5	142.25	232.75	445
3, ...	2	91.5	136.	227.5	410
5, ...	2	103.	138.5	241.5	437.5
7, ...	4	98.5	123.	221.5	400.
9, ...	7	119.5	98.	217.5	383.
11, ...	5	115.5	104.	219 5	390
13, ...	5	88.	109.	197.	356
15, ...	3	46.5	127.5	174.	340
17, ...	6	52 75	138.75	191.5	355
19, ...	4	76.	143.	219.	400

It should be noted that from an error in making and planting, made by the unskilled hands assigned me, it became necessary to transplant several rows of corn on plats 13, 15 and 17, and that although the greatest care was taken in the work, the transplanted hills were checked in their growth and never fully matured. This will, in part at least, account for the lower yield of both stalks and corn on these plats.

The corn from plats 0, 1, 3, 5, 7, 13 and 19, was put in thin bags and placed on racks suspended by wires over the barn floor for further drying; and the stalks from plats 0, 1, 3, 5 and 7 were likewise separately stored, so that they could be again weighed.

These reserved samples were re-weighed November 17, with the results given in Table II. The loss in drying, per acre, is given in *italic*.

Both stalks and corn are still preserved for weighing at intervals during the winter and spring:—

TABLE II.

PLATS.	Sound Corn, lbs.	Soft Corn. lbs.	Total Corn. lbs.	Stalks. lbs.
0, ...	207.5	88.5	296.0	447.5
	170.0	*130 0*	*300.0*	*1305.0*
1, ...	83 0	122.5	205.5	345.0
	75.0	*197.5*	*272.5*	*1000.0*
3, ...	83.0	115.0	198.0	320.0
	85.0	*210.0*	*295.0*	*900.0*
5, ...	94.75	119.0	213.75	345.0
	82.5	*195.0*	*277.5*	*925.0*
7, ...	85.0	101.25	186.25	315.0
	135.0	*217.5*	*352.5*	*950 0*
13 ,, ...	79.5	91.25	170.75	
	85.0	*177.5*	*262.5*	
19, ...	67.25	123.5	190.75	
	87.5	*195.0*	*282.5*	

DRAINAGE WATERS FROM EXPERIMENTAL CORN PLATS.

As an introduction to this subdivision of my report, it may be well to make a condensed statement of some of the results of the latest researches in regard to the relations of the soil to the supplies of plant food which have prompted me to give such prominence to the investigation of drainage waters in the "Plan of Experiments," drawn up for the consideration of the Board of Control.

It has long been known that nitrogen, in some form, was essential in the processes of plant-growth, but its immediate source and the form in which it could be appropriated were matters of conjecture only, while the abundance of free nitrogen in the atmosphere furnished the basis of hypotheses that have not stood the test of experimental investigations.

The researches of Boussingault, in connection with the later and more exhaustive experiments of Lawes and Gilbert

and Righ at Rothamstead, seem to show conclusively that the free nitrogen of the atmosphere is not the direct source of the nitrogen of plants.

From later investigations it appears to be settled that most of our farm crops, and particularly the cereals, take up nitrogen only in the form of nitric acid; but it is perhaps probable that leguminous plants, and possibly Indian corn, may make use of nitrogen in organic combination, which is not available for other plants.

According to the latest report (1883) on the rainfall at Rothamstead, the total amount of combined nitrogen in the average annual rainfall, of twenty-nine inches, is estimated by Lawes and Gilbert and Warrington at 4.5 lbs. per acre, and they say, "As to the amount of gain by absorption by the soil, there is unfortunately no direct or satisfactory evidence at command. From such evidence as does exist, we are disposed to conclude that with some soils the amount will probably be greater, and with others less than that supplied by the rainfall."

It will not, therefore, be safe to estimate the atmospheric supplies of nitrogen at more than 10 lbs. per acre, annually, and this must be obtained through the medium of the soil, the direct absorption of the ammonia of the air, by plants, being so slight that practically it need not be noted.

As our farm crops contain on the average from twenty-five to considerably more than one hundred pounds of nitrogen per acre, we must look to the soil and to the manures applied as the principal source of available nitrogen.

A large part of the nitrogen of the soil is in organic combination, but nitrogen in this form, as well as that in nitrogenous organic substances and ammonia salts that are applied as manure, must be transformed into nitric acid before it is available for plant growth.

But little has been known in regard to this process of nitrification until within a few years past, notwithstanding the theories that have been formed to account for it.

From the experiments of Schloessing and Muntz, which were first published in 1877, it is evident that the nitrification of soils is caused by a living organism, which acts as a

ferment, and they afterwards, by a system of cultivations, isolated and identified the specific form as a member of the family of bacteria.

The experiments on nitrification made by Warington at Rothamstead in 1877, 1878, and 1879, have fully substantiated the claims of the French chemists, and furnished additional information of practical value in regard to the *rôle* of the bacterium that performs such an important part in the process of vegetable nutrition.

These bacteria abound in every fertile soil, and as a function of their vital activity are constantly transforming the nitrogen of organic substances and of ammonia, in the surface soil, into nitric acid, when the proper conditions of moisture and temperature are present.

The bacteria of nitrification are most active at a temperature of about 99° F. — they act slowly when the temperature is lowered to near the freezing point, or when it is raised to 122° F., and at 131° F. their peculiar function as a ferment ceases.

Another important condition is essential to rapid nitrification, namely, the presence of an excess of some salifiable base, as carbonate of calcium, so that nitrates can be readily formed. This accounts for the action of lime when applied to peaty soils, which has not heretofore been satisfactorily explained.

The nitrates, as found, may be at once taken up by the roots of living plants, or, in their absence, they will be washed by the rains to the lower strata of the soil beyond the reach of shallow-rooted plants, or they may be lost entirely in the drainage waters.

It must therefore be seen that the nitrification of soils, and the conservation of the nitrogen in the form of nitrates are biological processes involving the activities of living organisms.

During the summer the process of nitrification is carried on rapidly, and the nitrates are taken up by the growing crops; but after harvest, on cropped land — and where land is fallowed — the nitrates accumulate in the surface soil until the fall rains wash them down to the lower strata.

A few examples from the experiments at Rothamstead will sufficiently illustrate the behavior of the nitrates in the soil.

The soil of the drain-gauges at Rothamstead (of $\frac{1}{1000}$ of an acre in area), is unmanured and uncropped, representing in fact the conditions of a bare fallow. The loss of nitrogen in the drainage waters of the gauge, sixty inches deep, amounted to 42.64 pounds per acre annually on the average for five years. This loss was distributed as follows: —

For the three months January–March, . .	9.92	pounds per acre.
For the three months April–June, . . .	6.10	pounds per acre.
For the three months July–September, . .	10.80	pounds per acre.
For the three months October–December, .	15.82	pounds per acre.
Total, ...	42.64	pounds per acre.

On land cropped continuously with wheat, the loss of nitrogen in the drainage waters was estimated as follows: On plats that received no nitrogenous manures, the average loss for two seasons of excessive drainage was from 15 to 17 pounds of nitrogen per acre, while the average for thirty years was from ten to twelve pounds per acre.

Where from 43 to 129 pounds of nitrogen was applied in the form of ammonia salts, the loss of nitrogen by drainage was estimated at from 19 to 42.4 pounds per acre annually.

These experiments with drainage waters have been supplemented by an extended and systematic examination of the soils.

In the Hoos field, which has been alternately in wheat and fallow since 1851 without manure, samples of the soil were taken in September, 1878, with the following results: —

DEPTH.	NITROGEN AS NITRATES IN LBS. PER ACRE.	
	From half of the field in wheat.	From half of the field in fallow.
First 9 inches, ...	2.6	28.5
Second 9 inches, ...	Trace.	5.2
Total in 18 inches, ...	2.6 lbs.	33.7 lbs.

The wheat had evidently taken up the nitrates as they had been formed, and losses of nitrogen by drainage would not be likely to take place until after harvest. "In three soils

at Rothamstead, in fair agricultural condition, cultivated as bare fallows since the harvest of the previous year, 56.5, 58.8 and 59.9 pounds of nitrogen, as nitric acid, per acre, were found in September or October to the depth of 27 inches. If the summer has been dry, the nitrates are near the surface; after much rain they are at a lower level.

Without further discussion of these valuable and interesting experiments, it will be clearly seen that the work of experimentation in this field of research can no longer be retarded by the vague and indefinite problems presented by former crude theories. From our present knowledge of the process of nitrification, and of the relations of the elements of fertility to the soil under different conditions, all of which is largely owing to the remarkable series of experiments conducted at Rothamstead for the past forty years, the lines of investigation that give promise of immediately practical results are well defined and can be readily followed.

Experiments are now needed to determine the applicability of the results obtained at Rothamstead to the different climatic conditions that prevail in this country. That the general relations of the plant-food to the soil are the same cannot be doubted; but we need information as to the modifying influences of the varied conditions.

Drainage Waters of the Experimental Corn Plats.

In the selection and arrangement of the experimental corn plats, as well as in the construction of the drains, particular care has been taken to secure uniformity in all conditions that could possibly have an influence on the composition of the drainage waters.

When the work of digging the trenches for the tiles was begun, April 16, the soil was saturated with water within about twelve inches of the surface.

The water table was of course lowered as the drains were laid, and for some time before the last laterals were finished, May 10, the two-inch drains had stopped running, and there was but little water even in the main drains. A heavy rain fell on the night of May 21, and continued through the following day.

The drains on plats 3 and 13 and the "headers" B and C, were running at 10 A.M. on the 22d inst., and at 11 A.M. all the drains were running with the exception of the one on plat 19.

Samples of the drainage waters, for analysis, were taken from plats 0, 3, 13, and from the "header" C. That from plat 0 was not clear.

At 1.30 P.M. all the drains were running, and the water was clear, with the exception of that from plat 7, which was slightly turbid. The drains from plats 15, 17 and 19 discharged less than the others.

At 2.30 P.M. samples of the drainage waters were taken for analysis from all the plats and from the headers B and C. At 5 P.M. the header C was running full, the drains on plats 0, 1 and 3 nearly full, and all others more than half full.

Later in the evening all the drains were running full. On the 23d inst. all the drains were running a good stream at 11 A.M., and the discharge from the laterals continued until June 2, heavy showers having fallen on the 28th and 31st of May. The samples of drainage waters were taken to the laboratory, where they were analyzed under the supervision of Director Goessmann, with the results given in the following Table: —

Composition of the Drainage-waters from the Experimental Corn Plats, May 22, 1883.

PLAT.	Time of taking Samples.	PARTS PER MILLION.							GRAINS PER GALLON.			
		Free Ammonia.	Albuminoid Ammonia.	Total Ammonia.	Nitrogen as Ammonia.	Nitrogen as Nitrates.	Total Nitrogen.	$CaCO_3$ (Hardness).	Solids.	Potassium Oxide.	Phosphoric Acid.	Chlorine.
0, ...	11 A. M.	.13	.09	.22	.18	.70	.88	27.3	7.5	.18	Trace.	.4
0, ...	2.30 P. M.	.11	.06	.17	.14	–	.14	16.9	5.0	.15	Trace.	.4
1, ...	2.30 "	.08	.11	.19	.16	16.26	16.42	*	*	*	*	*
3, ...	11 A. M.	.01	.07	.08	.07	.27	.34	28.6	4.5	.13	Trace.	.5
3, ...	2.30 P. M.	.45	.06	.51	.42	.19	.61	19.5	2.5	.13	Trace.	.3
5, ...	2.30 "	.02	.07	.09	.07	–	.07	23.4	2.5	.11	Trace.	.3
7, ...	2.30 "	.01	.10	.11	.09	.05	.14	27.3	4.5	.18	Trace.	.3
9, ...	2.30 "	.02	.09	.11	.09	.06	.15	23.4	3.5	.14	Trace.	.4
11, ...	2 "	.01	.10	.11	.09	.09	.18	22.1	4.0	.09	Trace.	.2
13, ...	11 A. M.	.01	.08	.09	.07	.17	.24	22.1	4.0	.12	Trace.	.3
13, ...	2 P. M.	.01	.10	.11	.09	.13	.22	20.8	3.8	.21	Trace.	.3
15, ...	2 "	.01	.07	.08	.07	.03	.10	2.0	4.5	.04	Trace.	.3
17, ...	2 "	.01	.10	.11	.09	.05	.14	45.7	9.0	.07	Trace.	.3
19, ...	2 "	.01	.12	.13	.11	.17	.28	41.6	9.0	.31	Trace.	.4
C, ...	11 A. M.	.01	.12	.13	.11	.14	.25	18.2	2.3	.07	Trace.	.5
C, ...	2 P. M.	.01	.15	.16	.13	–	.13	15.6	3.3	.04	Trace.	.4
B, ...	2.30 "	.01	.11	.12	.10	.07	.17	18.2	2.5	.03	Trace.	.3

* Not determined.

The exceptionally high yield of nitrogen in the drainage water from plat 1, as given in the Table, can only be explained on the supposition that the labels of the samples from plats 0 and 1, collected at 2.30 P.M., have been transposed, either when sampling in a pouring rain or afterwards. The composition of the sample of plat 1, as given in the Table, is approximately what might be expected in the sample from plat 0, from what is known of its characteristics and previous history. The record is, however, given as it was made, and future analysis of the drainage waters from these plats may explain the apparent anomaly.

There was quite as much nitrogen in the drainage waters of most of the plats as could reasonably be expected under the conditions and at the time of year when they were collected.

The soluble nitrogen of the soil had been washed out by the spring rains before the tiles were laid, and during the cold and backward spring the process of nitrification had not been carried on actively.

The composition of the drainage waters may have been somewhat modified by the conditions under which they were collected, as they were the first waters discharged by the tiles that had just been laid.

The season has been a remarkably dry one, and the drains have not been running since June 2.

The water table was raised to the grade of the main drain by the fall rains, but the laterals have remained dry.

To carry out these experiments in a manner that will secure the best practical results in the shortest time, three drain-gauges should be provided to determine the relations of the rainfall to the drainage under different conditions of management, — and laterals should be laid in the upper tier of plats, which should be devoted to crops in systematic rotation.

The entire expense of these additional facilities for experimenting will probably not exceed $450.

In a matter of so much importance to the farmers of the State, there should be no difficulty in securing the required appropriation.

It is certainly bad policy to buy fertilizers to supply a waste of the elements of fertility in the soil, which may be prevented by better methods of management; and these can only be determined by carefully conducted experiment.

[Exhibit E.]

REPORT ON ENSILAGE.

Silo.

The silo, 10.5 by 14.1 feet, inside measure, and 11 feet deep, for experiments with ensilage, has been made in one corner of the feeding barn, and entirely above ground.

In its construction the aim has been to secure a practically air-tight box with the least possible expense.

The lower two feet of the silo is enclosed with brick walls, nearly two feet in thickness, which form on two sides the foundation walls of the building, the earth on the outside being graded nearly to the level of the sills.

Above the brick work the walls of the silo are made with six-inch studs, in contact with the sheathed and clapboarded covering of the barn on two sides, and the inner walls are covered with matched boards on the outside. The lining of the silo consists of two thicknesses of one-inch matched boards, nailed firmly to the studs, with sheets of tarred paper between them to make the walls as nearly air-tight as possible. In this way a dead-air space of six inches is secured in the walls on all sides.

Door.

The door of the silo, opening on the barn floor, is made of pieces of two-inch planks, planed to a thickness, and battened with a lining of one-inch planed boards. These pieces forming the door are placed crosswise of the doorway, fitting closely inside the jambs, with the inner surface flush with the inside of the wall of the silo. The door is kept in place by planed 2 by 4 scantling, fastened to the jambs of the doorway with square-headed screw bolts, technically called "lag-screws," to sustain the pressure of the ensilage on the door.

By this arrangement access is gained to the ensilage by taking out the lag-screws with a wrench, and removing the scantling that support the door, and then taking the door out piece by piece, and thus exposing the wall of ensilage pressing against it.

The cover of the silo consists of a course of two-inch planed planks, cut five-eighths of an inch shorter than the diameter of the silo, and covered with a course of one-inch planed boards breaking joints with the planks. As the planed surface and edges of the boards and planks fit closely together, the cover is practically air-tight, with the exception of the slight space around the edges which must be left to prevent binding against the walls of the silo as the ensilage settles.

Weights.

The required pressure is obtained by means of cement barrels filled with earth.

Barrels or boxes of earth or stones are, in my experience, the best and most convenient weights for a silo, as they give a uniform and constant pressure. Screws are objectionable as they do not give a constant pressure and must be tightened once or twice a day for several weeks, and the labor involved is more than will be required to supply the needed load of earth or stones.

Fodder Corn.

The fodder corn for filling the silo was grown on the west tier of experiment plats, and on a small piece of ground west of the plats in experimental grasses.

No manure was applied, as the condition of the soil for future experiments was a matter of greater importance than a large crop of fodder corn this year.

"Longfellow" corn was sowed in drills thirty inches apart July 5. From the late time of planting, a small variety of corn was selected in preference to the larger sorts, which require a longer season to mature.

The corn made a rapid growth, and it was well tasselled out, when it was struck by the frost on the night of Sept. 3.

As soon as help could be obtained the fodder corn was harvested and put in the silo, the cutting to $1\frac{1}{4}$ inch lengths being done by hand-power.

15212.5 pounds were cut and put in the silo Sept. 6; 13850.0 pounds were cut and put in the silo Sept. 7; and 5327.5 pounds, harvested the preceding day, were cut and put in the silo Sept. 8. The total of green fodder was 17 tons 390 lbs.

The corn was well tramped down as it was put in the silo, and at night when work was stopped the surface was carefully levelled and left without covering until morning.

The night of the 6th the mass settled about two inches, and on the night of the 7th it settled three inches.

The cover was put on and weighted with earth to give an estimated pressure of something over 60 pounds to the square foot, in the afternoon of the 8th.

The mass, before covering and weighting, filled the silo to the depth of $8\frac{1}{2}$ feet, and the temperature two feet below the surface was 82° F.

Temperature.

For the convenience of future observations a gas pipe $1\frac{1}{4}$ inches in diameter and four feet long, with sharp edges, was driven through a hole in the middle of the cover, and the upper end was securely packed to make a tight connection with the planks of the cover, while the top was closed with a plug.

The temperature of the ensilage at the bottom of this tube, and the temperature of the air outside, together with the settling of the surface of the mass of ensilage, were frequently observed with the results given in the following table. Whenever a change in the temperature was noticed the observation was immediately repeated, to eliminate all possible errors. The observations on the depth of ensilage were taken from a single point until the 18th inst., when irregularities in the rate of settling were noticed, and the observations were afterwards taken from four points, the average of them being given in the table: —

Observations on the Ensilage.

DATE.	Depth of Ensilage.	Temperature of Ensilage 4 ft. from the surface.	Temperature of Outside Air.	Remarks.
Sept. 8,	8 ft. 6 in.	82° F.	–	2 ft. below surface before covering.
" 9,	7 " 7 "	82° "	–	
" 10,	7 " 2¾ "	78° "	–	
" 11,	6 " 9 "	77° "	–	
" 12,	– –	82° "	62°	
" 14,	– –	84° "	55°	
" 15,	5 ft. 11½ in.	84° "	68°	
" 16,	5 " 11¼ "	87° "	72°	
" 17,	5 " 10½ "	85° "	69°	
" 18,	5 " 9¾ "	82° "	59°	
" 19,	5 " 9¾ "	84° "	–	
" 20,	5 " 9½ "	84° "	61°	
" 21,	5 " 9¼ "	84° "	62°	
" 22,	5 " 9 "	83° "	56°	
" 24,	5 " 9 "	82° "	61°	
" 25,	5 " 8½ "	80° "	58°	
" 26,	5 " 8¼ "	80° "	50°	
" 27,	5 " 7¾ "	80° "	50°	
" 28,	5 " 7½ "	80° "	60°	
" 29,	5 " 7¼ "	79° "	53°	
" 30,	5 " 7¼ "	78° "	59°	
Oct. 1,	5 " 7⅛ "	78° "	50°	
" 2,	5 " 7⅛ "	76° "	48°	
" 3,	5 " 7 "	76° "	44°	
" 4,	5 " 6⅞ "	76° "	43°	
" 10,	– –	68° "	–	
" 27,	– –	65° "	–	
Nov. 7,	– –	64° "	–	
" 18,	– –	59° "	–	
Dec. 3,	– –	54° "	–	
" 15,	5 ft. 5½ in.	49° "	22°	

It will be seen that the ensilage did not settle at a uniform rate, as might be expected from the constant pressure applied, and the variations are greater than can be attributed to errors of observation, as the measurements were taken with the greatest exactness, and they were repeatedly verified by re-measurement. Frequent examinations of the edges of the cover failed to detect any indication of obstruction by pressure on the walls of the silo.

Temperature.

The temperature of the ensilage on the 9th inst. was the same as on the previous day, before the cover was put on

(82°), but there was a fall of 5° in the course of the next two days. A rise of temperature then followed, reaching the maximum of 87° on the 16th, and during the next two weeks there was a depression of but 9°. The fall in temperature in the following two and one half months was only 29° to the lowest observation recorded (49°), which is still above the temperature of the outside air.

Bacteria.

Samples of the ensilage were taken from time to time through the tube, at depths of from four to five feet below the surface, for microscopic examination.

The sample taken on the 9th inst., when the temperature was observed, swarmed with bacteria, which were remarkably active, and rapidly increasing by self-division.

Since the temperature has fallen below 60° the apparent activity of the bacteria has been slightly diminished. This may be attributed to the lower temperature and increasing acidity, but the relative influence of each has not been determined.

Fermentation.

There are two classes of ferments now generally recognized: 1st, the so-called soluble or chemical ferments, as acids and diastase, which "invert" cane sugar and transform it into dextrose, or change starch into dextrine, etc., and these, according to Dumas, "always sacrifice themselves in the exercise of their activities." 2d, The true ferments, which from the discoveries of Schwann (1838), and the elaborate and exhaustive experiments which have been made by Pasteur in the past twenty years, are now known to be living organisms that produce fermentation as a function of their vital activity.

The true fermentations are, therefore, purely physiological processes, which are defined by Pasteur as "the direct consequence of the processes of nutrition, assimilation and life, when they are carried on without the agency of free oxygen," or "as a result of life without air." Unlike the soluble ferments, these living organisms increase at the expense of the substances fermented.

These organized ferments, which belong to the class of fungi, may be divided into two groups, the *Saccharomycetes* or budding fungi, — the active agents of alcoholic fermentation, of which yeast may be taken as the type; and the *Schizomycetes*, or fission fungi, which include the lactic, butyric, and similar ferments, and the ferments of putrefaction; most of them are of the forms known as bacteria, and they multiply rapidly by subdivision. All the members of both groups probably propagate by means of spores, but this method of reproduction has not been observed in many species belonging to the last mentioned group.

The living organisms of fermentation found in samples of fresh ensilage, all belong to the group of Schizomycetes (bacteria). No members of the group of Saccharomycetes (yeast or alcoholic fungi) have been observed in samples from the interior of the silo that had not been exposed to the air.

After the silo is opened and a large surface is exposed to the air, the "yeast fungi" and even the "moulds" may be found, but they are evidently the result of germs derived from the air after the silo is opened.

We do not include the "mould fungi" in the class of ferments proper, as Pasteur has shown that they act as ferments under exceptional conditions only, and even then they do not produce active fermentation.

The ferments of the first mentioned group have been studied more thoroughly than the others, from their importance in the manufacture of beer, wine, etc., but many of the facts developed in their investigation are undoubtedly applicable to the ferments of the other groups.

From experiments with fruits in an atmosphere of carbonic acid, Pasteur has apparently shown that any vegetable cells which are capable of extracting their needed supply of oxygen from organic combinations may, by this manifestation of their vital activity, act as ferments; and the true ferments are distinguished from these, not by a difference in their specification, but from the fact that they are capable of carrying on the functions of nutrition and assimilation with much greater activity without a supply of oxygen in the air.

Pasteur has likewise proved that the alcoholic ferments

develop rapidly in the presence of air, but their function as ferments is impaired by this ready supply of oxygen.

In the absence of air, as in an atmosphere of carbonic acid, they take their supply of oxygen from organic substances, like sugar, and their function as ferments is increased.

When the life of the bacteria, or other organized ferments, is destroyed, the process of fermentation, or putrefaction, ceases; and this takes place, — according to the observations made in the course of the controversy in regard to spontaneous generation,— at a temperature of from 122° to 140°, and if the germs that produce the bacteria are then excluded, the process of fermentation, or of putrefaction, cannot again take place.

The canned articles of food, which are now so common in the markets, furnish an illustration of the application of this principle. In their preparation heat is applied, which kills the bacteria, — the active agents of fermentation, — and they are then sealed in air-tight cans to prevent the access of a fresh supply of germs from the atmosphere.

That the germs which produce the bacteria of fermentation and putrefaction are abundantly distributed in the air, has been conclusively proved by the experiments of Pasteur and Tyndall, and the supposed cases of spontaneous fermentation or putrefaction are readily explained by the seeding of the fermenting substances with the germs derived from the atmosphere.

The various and conflicting reports that are made in regard to the quality of ensilage, including the degree of acidity, its influence upon the quality of milk, and its general feeding value, can only be explained by differences in the quality and maturity of the crops from which it is made, together with the different methods of securing it, all of which must have an influence on the process of nutrition in the bacteria, and therefore produce variations in the results of fermentation.

The molecular changes taking place under such different conditions cannot be expressed in any definite chemical formula. As fermentation is strictly a physiological process, the fermented product may be looked upon as the *residuum*

of what is required in the nutritive functions of the bacteria that produce it.

In advocating these views Pasteur says: "Originally, when fermentations were put amongst the class of decompositions by contact-action, it seemed probable, and, in fact, was actually believed, that every fermentation had its own well-developed equation, which never varied.

"In the present day, on the contrary, it must be borne in mind that the equation of a fermentation varies essentially with the conditions under which that fermentation is accomplished, and that a statement of this equation is a problem no less complicated than that in the case of the nutrition of a living being. To every fermentation may be assigned an equation in a general sort of way, — an equation, however, which in numerous points of detail is liable to the thousand variations connected with the phenomena of life. Moreover, there will be as many distinct fermentations brought about by one ferment as there are fermentable substances capable of supplying the carbon element of the food of that same ferment, in the same way that the equation of the nutrition of an animal will vary with the nature of the food which it consumes. As regards fermentation producing alcohol, which may be effected by several different ferments, there will be, in the case of a given sugar, as many general equations as there are ferments, whether they be ferment-cells, properly so called, or cells of the organs of living beings functioning as ferments. In the same way the equation of nutrition varies in the case of different animals nourished on the same food. These remarks are applicable to all ferments alike; for instance, butyric ferment is capable of producing a host of distinct fermentations, in consequence of its ability to derive the carbonaceous part of its food from very different substances, from sugar, or lactic acid, or glycerine, or mannite, and many others. Moreover, it is quite erroneous to suppose that the presence of a single one of the products of a fermentation implies the co-existence of a particular ferment. If, for example, we find alcohol among the products of a fermentation, or even alcohol and carbonic acid gas together, this does not prove that the ferment must be an alcoholic ferment, belonging to alcoholic fermentations

in the strict sense of the term. Nor, again, does the mere presence of lactic acid necessarily imply the presence of lactic ferment. As a matter of fact, different fermentations may give rise tc one or even several identical products."

From this statement of the physiological conditions that modify the products of fermentation, it must be seen that uniformity in the quality of ensilage can only be secured by preventing fermentation altogether, or reducing it within the narrowest possible limits. This can only be done by destroying the bacteria of fermentation in the earliest stages of their activity, which would result in the production of ensilage free from acidity, and closely resembling in quality the green fodder from which it is made.

If the bacteria can be killed, when the silo is covered and weighted, the enclosed mass of ensilage will be practically preserved under the same conditions as fruits, or vegetables, or meats are preserved when canned. The practical question, then, presents itself as to how this can best be accomplished.

An extended series of observations on samples of the ensilage from the experimental silo, have already been made, and are still in progress, to determine the temperature required to kill the bacteria which are the cause of fermentation. This will, without doubt, vary somewhat with the kind of produce under treatment and its condition at the time of harvest. Thus far my experiments seem to indicate that a temperature of from 115° to 122°, maintained for one or two hours, will be sufficient to kill the bacteria under the conditions in which they are now placed.

The time of exposure, as well as the temperature, must have an important influence on the result.

A degree of heat that would kill the mature and active bacteria would not, in all probability, kill the germs which might produce a succeeding generation if the given temperature was continued but a short time.

From observations on the temperature of the silo after it was covered and weighted, it may with reason be expected that the initial temperature will remain nearly constant for several days, and perhaps for weeks, which would ensure the destruction of any successive generations of bacteria that

might be developed from the germs that had not been killed.

In the ordinary process of filling a silo the object aimed at is to prevent fermentation by keeping the green fodder well packed as it is put in, and even under these precautions the temperature of the mass often rises above 100°. I have observed a temperature of 105° when the greatest care had been taken in packing the silo as it was filled.

With less tramping of the mass, and when the work of filling the silo is extended over a period of several days, the temperature may rise to a point that is fatal to the bacteria; and this may be the explanation of the reported cases in which the ensilage is said to be "sweet," or free from acidity.

When the precise conditions as to the required temperature are known, the better plan may be to fill the silo without any packing beyond what is produced by the weight of the superincumbent mass, and then allow it to remain until the desired temperature is reached, before putting on the cover and weights.

The best method can, however, only be determined by carefully conducted experiments that are made with a full knowledge of the different conditions that may have an influence in modifying the results. It cannot, however, be doubted that acidity in the ensilage can only be produced by conducting the process so that the temperature does not rise above the point that is fatal to the bacterial ferment (probably 115° to 120°).

In filling silos, observations on temperature have been generally neglected, and we therefore lack the necessary data for determining the precise temperature required to prevent fermentation, or the conditions under which it may be produced, from the results of practical experience. But a single case has come to my knowledge, where such observations have been made, when the resulting product was sweet ensilage. Mr. George Fry of England reports the results of some experiments made the present season, which are of particular interest in connection with the observations recorded above.

In a silo, filled with "rough grass" and "clover and rye

grass" between the 7th and 30th of June, the temperature at the time of covering was 132°, at a depth of six feet from the surface. The cover was weighted with twelve inches of sand.

On July 11th, and again on the 17th, the cover was taken off and the silo was filled with "meadow grass" to make up for the loss in settling.

The temperature observed at these dates was 140° at a depth of six feet from the surface.

In another silo, filled with "clover and rye grass" and "meadow grass" between June 30th and July 11th, when the cover was put on and weighted, the temperature observed was—July 7th, 149°, and July 14th, 158°. The first-mentioned silo was opened October 25, and the ensilage is described as "of a brown color, and of a sweet, luscious odor, *free from acidity*, very much resembling that of ordinary hay." Cattle, sheep, and horses ate it at once with apparent relish.

These experiments seem to prove that a temperature sufficiently high to kill the bacteria and put a stop to fermentation can be readily obtained in the process of filling the silo.

Experiments are now needed to determine the precise temperature required and the most favorable conditions for securing it with different articles of food.

Ensilage in the Silo.

To carry on the experiments now in progress, the ensilage in the experimental silo should not be fed out until some time in March.

Additional facilities will be required to complete the investigations that are now in progress. An appropriation of $100.00 will be sufficient to provide the necessary outfit.

An engine is very much needed to furnish power for cutting fodder, and for other purposes, — a suitable one, with the necessary shafting and belting, may be procured at a cost not exceeding $500.

Amherst, Mass., Dec. 24, 1883.

[Exhibit F.]

EXPERIMENTS WITH PIGS.

The experiments in pig-feeding have been limited to some preliminary inquiries in regard to the influence of bran and cotton-seed meal when added to a ration composed principally of corn-meal.

As bran and cotton-seed meal contain a higher percentage of proteids than corn-meal, they should be valuable additions to the ration, if corn-meal as a fattening food is deficient in nitrogenous constituents. Ten pure-bred Berkshire pigs, from the College farm, were put in the experimental pens on the afternoon of October 23, but one pig being put in each pen. The age, sex, and weight of each pig is given in the following table: —

No. 1,	Sow, weight,	October 23,	58¾ lbs.	Born May 16, 1883.
" 3,	" "	"	59¾ "	
" 5,	Barrow, "	"	59¼ "	
" 7,	" "	"	42¼ "	
" 9,	" "	"	68¼ "	From two to three weeks older.
" 10,	" "	"	70 "	
" 8,	" "	"	61¼ "	
" 6,	Sow, "	"	67½ "	
" 4,	Barrow, "	"	60¼ "	
" 2,	" "	"	59¼ "	

For a preliminary period of five days, while getting accustomed to their new quarters, the pigs were all fed on corn-meal.

At the beginning of the experiment, on the morning of October 29, they were all again weighed, before feeding, and were then put on their assigned rations as follows: —

Nos. 5 and 6, — Corn-meal only.
Nos. 1, 2, and 8, — Corn-meal with cotton-seed meal.
Nos. 3, 7, and 4, — Corn-meal with bran.
Nos. 9 and 10, — Corn-meal with bran and cotton-seed meal.

A limited ration of bran and cotton-seed meal was given in the pens having the mixed food, and the corn-meal was fed to make out the full ration of as much as would be readily eaten.

The bran and cotton-seed meal were not apparently relished on the start, and the amount fed was determined in each case by the quantity that would be eaten with a good appetite.

An analysis of the feed was made in the laboratory, under the supervision of Director Goessman, which showed the composition to be as follows: —

	Corn-Meal.	Bran.	Cotton-Seed Meal.
Moisture, at 100° C.,	13.55	12.08	8.38
Crude Ash,	1.23	6.96	7.80
" Cellulose,	2.28	12.06	6.17
" Fat,	3.67	3.35	11.85
" Protein,	8.99	13 78	38.91
Non-nitrogenous Extract,	70.28	51.77	26.89
	100.00	100.00	100.00

To prevent any possible deficiency in the ash constituents, in feeding growing pigs with corn-meal alone, and to secure uniformity in all conditions, aside from the differences in food, leached ashes, with a few small pieces of charcoal, were kept in a separate trough in each pen, to which the pigs had uninterrupted access.

The weight of each pig at the beginning of each week, the feed consumed per week, and the average weight of each pig for each week, will be found in Tables 1, 2, and 3.

The amount of dry substance of food consumed per week by each pig, the amount of dry substance of food required to produce one pound of increase in live weight, and the gain for each 100 pounds of live weight, or the gain per cent. for each week, is given in Tables 4, 5, and 6.

Table No. I.

Weight of Each Pig at beginning of Preliminary Period, Oct. 23, and at the beginning of Each Week of the Experiments, — Weights taken Monday Mornings before feeding, from Oct. 29, 1883, — in Pounds and Decimals of a Pound.

DATE — 1883.	1	3	5	7	9	10	8	6	4	2
October 23,	58.75	59.75	59.25	42.25	68.25	70.0	67.5	61.25	60.25	59.25
" 29,	58.0	61.0	61.5	43.5	71.5	71.0	70.0	63.75	62.00	63.25
November 5,	60.5	68.5	59.5	46.5	78.0	77.75	73.5	67.75	65.00	72.75
" 12,	68.0	73.5	57.	47.5	85 5	81.25	82.75	75.25	71.25	76.00
" 19,	73.0	81.75	63.5	54.0	91.75	90.5	87.5	81.25	78.00	83.75
" 26,	77.0	87.0	70.0	57.0	103.75	95.5	104.25	90.5	85.00	92.00
December 3,	81.0	86.0	76.75	58.5	109.0	101.5	97.0	97.25	91.50	87.00
" 10,	79.5	87.5	84.5	59.0	115.5	104.0	105.5	104.5	98.00	83.5
" 17,	77.	87.5	85.0	60.0	121.0	103.0	102.25	110.0	–	–

TABLE NO. 2.

Feed Consumed, per Week, by each Pig in Pounds and Decimals.

PERIOD.	1.		3.		5.	7.		9.			10.			8.		6.	4.		2.	
	Corn-meal.	Cotton-seed Meal.	Corn-meal.	Bran.	Corn-meal.	Corn-meal.	Bran.	Corn-meal.	Bran.	Cotton-seed Meal.	Corn-meal.	Bran.	Cotton-seed Meal.	Corn-meal.	Cotton-seed Meal.	Corn-meal.	Corn-meal.	Bran.	Corn-meal.	Cotton-seed Meal.
Preliminary period, Oct. 23 to 29,	16.75	–	18.75	–	20.5	16.5	–	21.5	–	–	21.	–	–	22.13	–	21.5	20.13	–	20.13	–
Week ending Nov. 5,	15.31	2.85	20.5	5.88	20.75	9.5	5 75	21.	5.75	2.88	19.5	5.44	2.66	18.16	2.13	27.31	21.	5.63	23.63	3.94
Week ending Nov. 12.	15.88	2.63	24.94	5 25	11.13	10.5	5.25	21.	5.25	2.63	19 75	4 94	2.47	24.19	3.25	27.56	21.	5.25	21.13	3.94
Week ending Nov. 19,	15.75	2.63	24 94	5.25	15.69	10 5	7.75	20.5	4.88	2.56	20.25	4.81	2.53	18 63	3.81	28.19	21.	5.25	21.	3.94
Week ending Nov 26,	17.25	2.63	24.94	5.25	23.13	10.5	7.88	21.	5.25	2 63	19.	4.75	2.38	23.13	5.25	28.88	21.	6.56	18.5	3.47
Week ending Dec. 3,	18.38	2.63	19.13	4.13	26.69	10.5	9.19	20.5	5.13	2.56	18.	4.5	2.1	18.	3.63	30.63	21.	7.88	14.25	2.79
Week ending Dec. 10,	18.56	2 44	12 63	3.69	29.94	10.5	7.69	21.	5.25	2.63	15.75	3.94	1.31	18.	3.69	32.56	21.	7.88	7.06	1.94
Week ending Dec. 17,	11.63	.88	15.88	2.	20.94	11.25	4.06	20 25	6.34	2.56	15.44	1.88	1.	15.75	1.13	28.13	–	–	12.	–

TABLE NO. 3.

Average Weight of Pigs for Each Week in Pounds and Decimals.

DATE—1883.	1	3	5	7	9	10	8	6	4	2
October 23 to October 29,	58.38	60.38	60.38	42.88	69.88	70.50	68.75	62.5	61.13	61.25
Week ending November 5,	59.25	64.75	60.50	45.00	74.75	74.38	71.75	65.75	63.5	68.00
" " " 12,	64.25	71.00	58.25	47.00	81.25	79.50	78.13	71.5	68.13	74.38
" " " 19,	70.5	77.63	60.25	50.75	88.63	85.88	85.13	78.25	74.63	79.88
" " " 26,	75.0	84.38	66.75	55.5	97.75	93.00	95.88	85.88	81.50	87.88
" " December 3,	79.0	86.5	73.38	57.8	106.4	98.50	100.6	93.9	88.30	89.5
" " " 10,	80.25	86.75	80.63	58.75	112.25	102.75	101.25	100.83	94.75	85.25
" " " 17,	78.25	87.5	81.75	59.5	118.25	103.5	103.88	107.25	–	–

Table No. 4.

Dry Substance of Feed consumed, per Week, for each 100 lbs. of Live Weight in Pounds and Decimals.

DATE—1883.	1	3	5	7	9	10	8	6	4	2
October 23 to 29, . . .	24.8	26 9	29.4	33.3	26.7	25.8	27.9	29.8	28.5	28.5
Week ending November 5, .	25.1	35 3	29.2	31.6	35.3	32.7	24.6	35.9	36.5	30.1
" " " 12, . .	25.2	35.5	16.6	29 2	31 0	28.7	30.6	33.4	33.4	29.7
" " " 19, .	22.7	32.5	24.2	31.3	26.4	28.1	21.8	31.2	30.5	27.3
" " " 26,	23.1	29.7	33.0	28.8	25.8	24.6	25.9	29.1	29.4	16.8
" " December 3, . . .	23 2	23.4	31.5	28.1	23.1	21.8	23.0	28.2	28.4	16.7
" " " 10, . . .	22.8	15.3	32.2	26.9	22.4	17.9	17.7	27.9	26.4	9.5
" " " 17, . . .	13.9	18.3	21.4	22.4	21.5	15.4	13.1	23.8	–	–

TABLE NO. 5.

Dry Substance of Feed consumed required to produce 1 lb. of increase of Live Weight.

DATE—1883.	1	3	5	7	9	10	8	6	4	2
October 23 to 29,	*	11.6	7.9	11.4	5.7	18.2	7.7	7.4	9.4	4.4
Week ending November 5,	5.5	3.0	*	4.6	4.0	3.6	5.1	5.9	7.7	2.3
" " " 12,	2.1	5.0	*	13.7	3.4	6.7	2.6	3.2	3.6	6.7
" " " 19,	3.2	3.1	2.2	2.4	3.9	2.9	3.9	4.1	3.4	2.8
" " " 26,	4.4	4.8	3.1	5.3	2.1	4.6	1.5	2.7	3.4	1.7
" " December 3,	4.6	*	3.4	10.9	4.7	3.6	*	3.9	3.9	*
" " " 10,	*	8.8	3.3	32.0	3.9	7.4	2.1	3.9	3.9	*
" " " 17,	*	*	36.2	13.3	4.6	*	*	4.4	–	–

* No gain.

TABLE NO. 6.

Gain per 100 lbs. of Live Weight per Week.

DATE—1883.	1	3	5	7	9	10	8	6	4	2
October 23 to 29	—1 3	2.1	3.8	3.0	4.8	1.4	3.7	4.1	5.0	6.8
Week ending November 5, . . .	3.4	12 3	—4.1	6.9	9.1	9.5	5.0	6.3	4.8	15.0
" " " 12, . . .	12.39	7.3	—2 5	2.2	9.6	4.5	12 6	11.1	9.6	4.5
" " " 19, . . .	7.3	11.2	11.4	13.1	7.3	11.4	5.7	8.0	9.5	10.2
" " " 26, . . .	5.3	6.2	9.8	5.4	12.3	5.4	17.5	10.8	8.6	9.4
" " December 3, . . .	5.2	—1.2	9.6	2.6	5.1	6.3	—7.6	7.5	7.6	—5.9
" " " 10, . . .	—1.9	1.7	10.1	0.9	6.0	3.4	8.7	7.4	7.1	—4.
" " " 17, . . .	—3.1	0.	0.6	1.7	4.8	—1.0	—3.1	5.2	-	-

In the diagrams which follow, some of the leading facts recorded in the tables are presented in the graphic form, so that the results can be more readily compared.

The different pigs, and the kind of feed consumed by them, is indicated on all the diagrams as follows: —

A black line is given for pigs 5 and 6, which were fed corn-meal only.

A blue line is given for pigs 1, 2 and 8, which were fed corn-meal with cotton-seed meal.

A red line is given for pigs 3, 7 and 4, which were fed corn-meal with bran.

An interrupted line, blue and red, is given for pigs 9 and 10, which were fed corn-meal with bran and cotton-seed meal.

A scale at the side of the diagrams will show the weights indicated.

On diagram 1, the actual weight of each pig is given for each week, and the gain or loss can be readily traced.

In diagram 2, the initial weights are reduced to a common standard of one hundred pounds, and the lines show the gain or loss for each week for each one hundred pounds of live weight.

The dry substance of feed consumed per week, for each one hundred pounds of live weight, is given in diagram 3, and the dry substance of food consumed, required to produce one pound of increase in live weight, is given in diagram 4.

It will be noticed that the weights of pigs 4 and 2 are omitted in the tables and diagrams the last week of the experiment. No. 4 seemed to be in perfect health, when weighed on the morning of December 10, but a few minutes after he fell down in a "spasm," and died within ten minutes of the first attack, apparently of apoplexy. The only post-mortem indications of disease consisted in congestion of the membranes of the brain and medulla.

An examination will show that, in the uniform rate of gain during the experiment, — in the comparatively slight variations in the amount of food consumed in proportion to its weight, — and in the return for feed consumed, he had made one of the best records in the experiment.

Diagram 1. Weight of each pig at the beginning of the preliminary period — Oct. 23rd — and at the beginning of each week of the experiment.

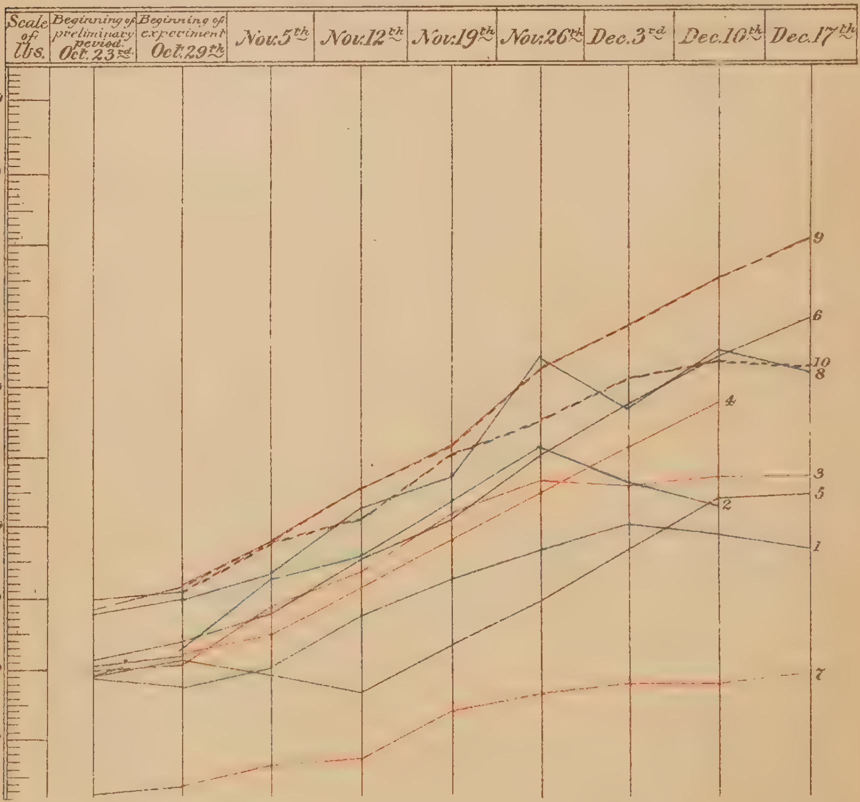


Diagram 2: Gain per each 100lbs, of live weight per week, or gain per cent.

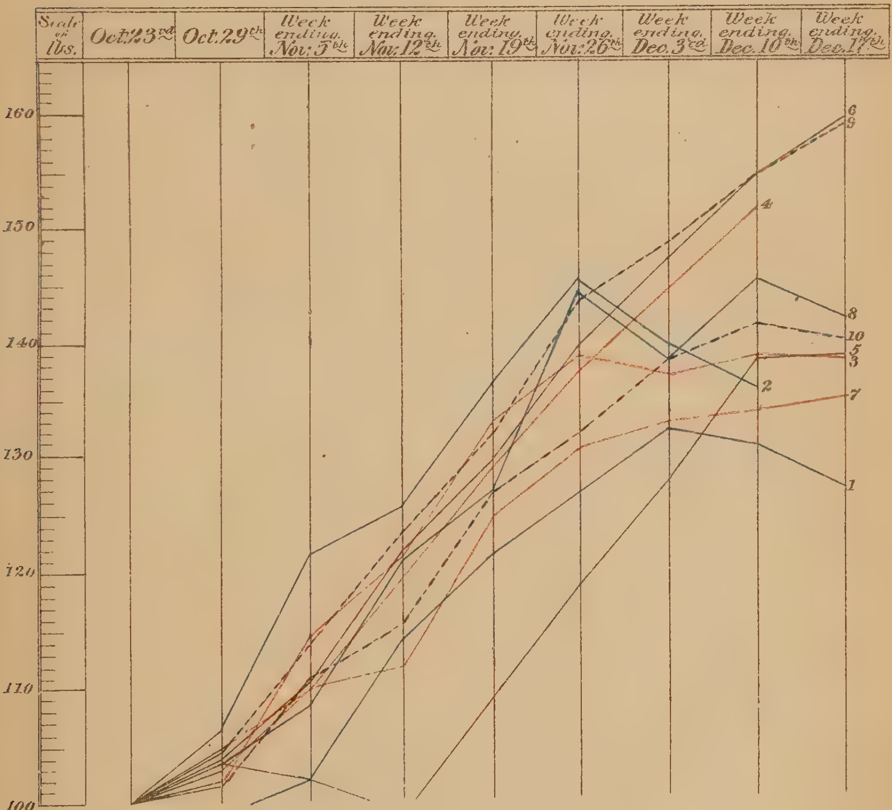


Diagram 3. Dry substance of feed consumed, per week, for each 100 lbs. of live weight.

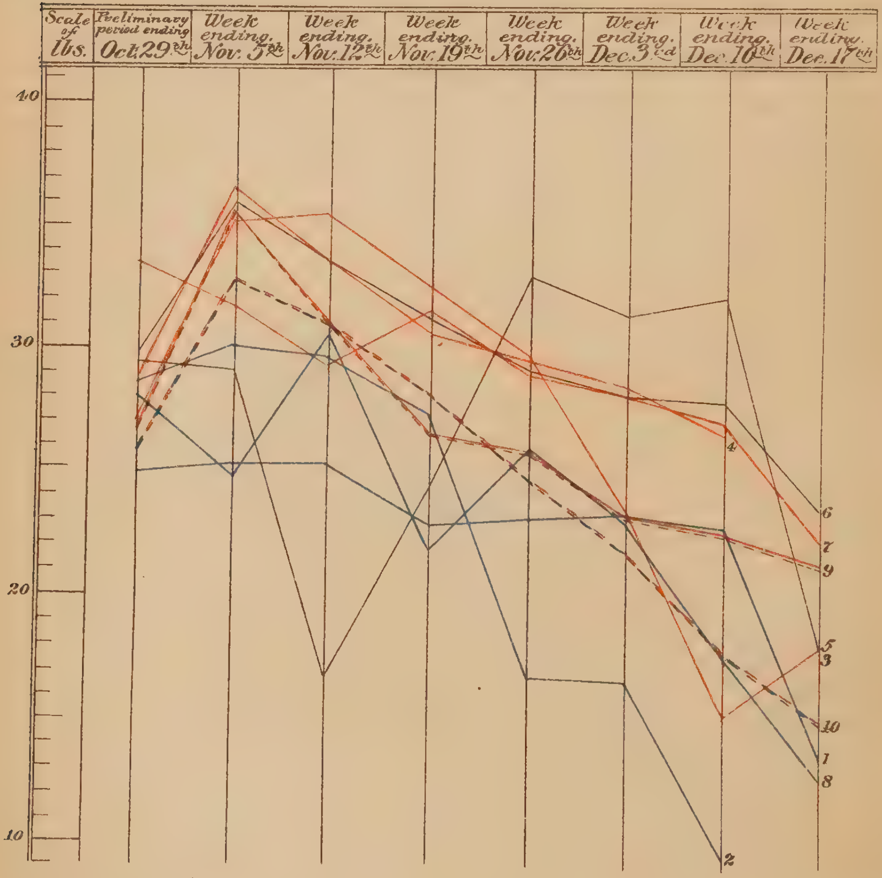
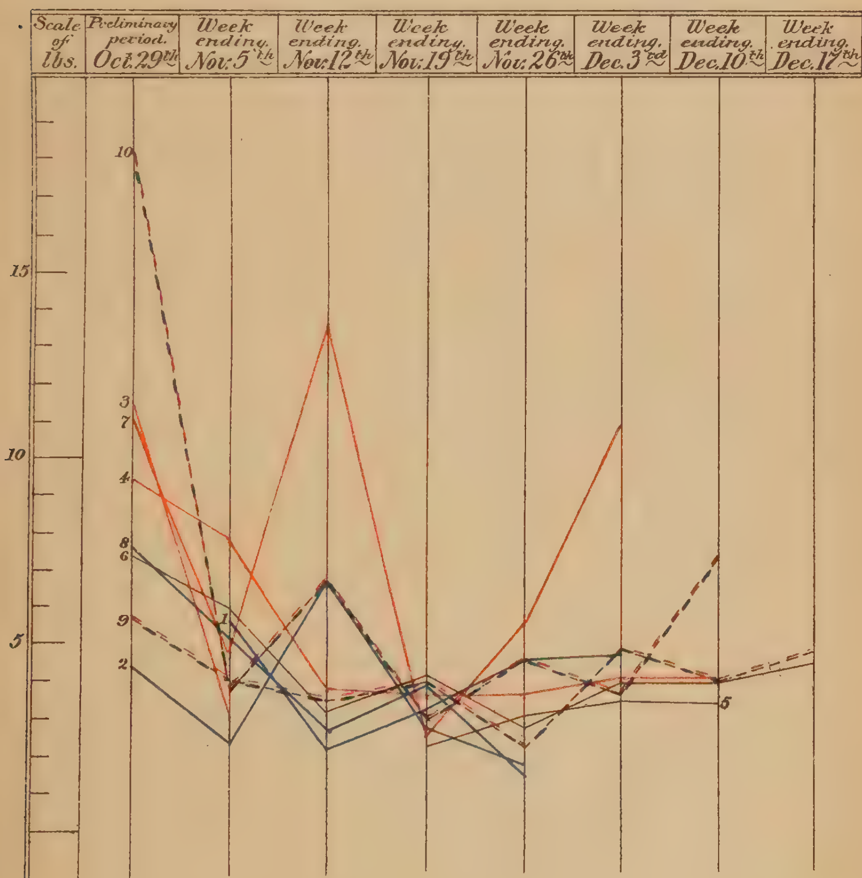


Diagram 4. Dry substance, of feed consumed, required to produce 1 lb. of increase of live weight.



A rheumatic affection of the hind legs of pig No. 2, accompanied with tenderness of the muscles and partial loss of motion, had been noticed for a few days at the close of the experiment, and he was not, therefore, weighed on the 17th.

The weather during the last week of the experiment was severe, the feed freezing in the troughs, and the thermometer, at times, nearly down to zero. Under these conditions, but two pigs (9 and 6) made a positive gain.

Pig No. 5 was sick, and lost weight the first two weeks of the experiment, which accounts for the low consumption of food recorded in table 2 and diagram 3, — during the next four weeks, however, with an exclusive diet of corn-meal, he made, on the whole, the best record, as will be seen by reference to table 5 and diagram 4.

The diagrams show that the feed required to produce a pound of increase in live weight varies from week to week, with the same food, and of the rations fed there is no particular one which seems to have an advantage, in this respect, over the others.

On the whole, the experiments fail to prove that corn-meal with bran or cotton-seed meal, or both, is a more valuable pig food than corn-meal alone.

HORTICULTURAL DEPARTMENT

OF

MASSACHUSETTS EXPERIMENT STATION.

To the Director and Board of Control.

GENTLEMEN : — The special work assigned to this department, and upon which I make the following report, is as follows : —

I. THE GROWTH AND CARE OF THE COLLECTION OF GRASSES AND FORAGE CROPS.

II. THE CARE OF THE FRUIT PLATS FOR DETERMINING THE EFFECT OF THE VARIOUS ELEMENTS OF PLANT-FOOD UPON THE COMPOSITION OF THE FRUIT.

III. TESTING THE VARIOUS KINDS OF NEW FRUITS.

IV. TO DETERMINE WHAT INFLUENCE THE STOCK MAY HAVE UPON THE SCION, IF ANY, IN GRAFTING.

V. STUDY OF DISEASES OF FRUIT AND OTHER TREES AND PLANTS, AND THE REMEDIES TO BE APPLIED.

VI. DESTRUCTION OF INJURIOUS INSECTS.

VII. GERMINATION OF SEEDS.

I.

Upon the land leased the Station by the College was found a collection of grasses and forage plants, consisting of the following species : —

Perennials.

Alopecurus pratensis, ...	Meadow foxtail.
Phleum pratense, ...	Timothy.
Dactylis glomerata, ...	Orchard grass.
Bromus secalinus, ...	Chess or cheat.
Bromus mollis, ...	Soft chess.
Bromus giganteus, ...	Great chess.
Lolium perenne, ...	Rye-grass.
Festuca elatior, ...	Meadow fescue.

Festuca ovina,	Sheep's fescue.
Festuca duriuscular,	
Festuca rubra,	Red fescue.
Festuca tenella,	Slender fescue.
Festuca gigantea,	Great fescue.
Agrostis vulgaris,	Red-top or Eng. bent.
Agrostis stolonifera,	Creeping bent.
Agrostis canina,	R. I. bent.
Poa pratense,	June-grass or Ky. blue-grass.
Poa trivialis,	Rough-stalked meadow.
Poa serotina,	False red-top.
Poa compressa,	Wire-grass.
Anthoxanthemum odoratum,	Sweet vernal.
Avena flavescens,	Yellow oat-grass.
Arrhenatherum avenaceum,	Wild oat-grass.
Aira cæspitosa,	Hair-grass.
Aira flexuosa,	Hair-grass.
Phalaris arundinacea,	Reed canary-grass.
Holcus lanatus,	Meadow soft-grass.
Calamagrostis Canadensis,	Blue-joint grass.

Annuals.

Phalaris Canariensis,	Canary-grass.
Solium Italicum,	Rye-grass.
Panicum Germanicum,	Hungarian millet.
Panicum Italicum,	Common millet.
Panicum miliaceum,	Golden millet.
Avena sativa,	Common oat.
Secale cereale,	Rye.
Triticum vulgare,	Wheat.
Hordeum vulgare,	Barley.
Sorghum vulgare,	Amber cane, Chinese, etc.

Leguminous.

Vicia sativa,	Vetch.
Lupinus perennis,	Blue lupine.
Lupinus luteus,	Yellow lupine.
Lupinus albus,	White lupine.
Trifolium pratense,	Red clover.
Trifolium hybridum,	Alsike clover.
Trifolium repens,	White clover.
Trifolium incarnatum,	Italian clover.
Mileletus albus,	Bokhara clover.
Lotus corniculatus,	Birdsfoot clover.
Medicage sativa,	Lucerne.
Ornithopus sativa,	Saradella.
Dolichos sinensis,	Cow-pea, var's "Whippoorwill and Clay."

The last mentioned was added to the collection this season.

The growth of the majority of the above has not been as good as could be desired, owing to the time they have been growing, — three or four years, — and many weeds have worked into the plats; so that, after gathering such specimens as were desired for analysis, they were ploughed under, and the collection will be increased as much as possible, and replanted early next spring.

The cow-peas and vetch were sown with oats and rye; but owing to the lateness of the season when the seed arrived, the growth was not sufficiently large to give a fair basis for determining their value.

II. Experimental Fruit Plats.

The trees and small fruits in these five plats have been under treatment for several years, and have yielded some fruit, which has been gathered for analysis.

The five plats into which the land was divided were planted with the same kinds of fruit in each; *i. e.*, apples, pears, peaches, plums, cherries, blackberries, raspberries, grapes, strawberries, currants and gooseberries, and is a good example of what may be done in close planting for a family fruit garden.

Four plats were fertilized with different elements of plant-food, and the fifth was left in its natural condition. The analyses of the fruit taken from these, made by Director Goessmann, and given in his previous reports, prove conclusively that the composition of fruits can be greatly affected by the application of special fertilizers.

The growth of the trees and plants has been very good; in fact, in some cases greater than is desirable for their most healthy development. This was especially the case with some of the peach trees, in which the growth of wood was so great and continued so late that it failed to mature, and the fruit buds were injured last winter, so that no fruit was borne the past season, while upon land less highly fertilized the trees produced large crops of fruit.

During the fall of 1881, and the winter of 1882, many of the trees in these plats were destroyed by cold, and all suf-

fered more or less, but no trace of the disease known as the *yellows* has made its appearance.

The soil upon which these trees are planted is a medium sandy loam, and well adapted to the growth of all kinds of fruits except the currant and quince.

III. Testing New Varieties of Fruits.

The soil to be devoted to this purpose is, like the above, well suited to the growth of all of the fruits except the currant and quince. The land has been prepared, and a few varieties of peach and apple trees planted.

IV. Influence of the Stock upon the Scion.

This experiment has only been started with some of the large fruits, but it is proposed to begin also with the smaller fruits and plants that require less time for development and maturity.

V. Diseases of Plants.

The time given to this subject has been largely in continuation of the study of the disease of the peach tree known as the *yellows*, which has for several years been carried on under the auspices of the college. In order to more fully understand the present condition of the experiment, I will give a brief history of the trees and the special treatment they have received.

The orchard originally consisted of about fifty trees, planted in 1870. For the first few years they received but little care. In the spring of 1873 all were carefully pruned to as good form as their condition would allow, the borers removed, and the soil manured and planted with squashes. The result was, that after a year or two they bore a good crop of fruit. After fruiting, many of the trees showed signs of disease, and a series of experiments were instituted with six or eight trees in 1878. The remarkable change made in these trees led to the continuance of the remedies upon all the peach trees in the college orchards that showed signs of disease. The results of the application of the remedies, when applied before the disease had made too great headway, have been entirely satisfactory; so much so

that most of the original trees are now in a healthy condition, although they have been thoroughly diseased, and the past season have borne as perfect fruit as is often produced by young trees.

Young trees have been planted where diseased trees were dug out, and the past season bore fruit. They are as healthy and vigorous as any trees in the orchard.

The remedies applied have been muriate of potash, from two to five pounds to the tree, sown in the fall or early spring, with ground bone or superphosphate, according to the condition of the soil, which, if very poor, should have an additional dressing of organic matter, like stable manure. In addition to these remedies, the borers (the larvæ of the moth, *Ægeria exitiosa*) have been dug out with a knife twice each year, — in June and August, — and the trees kept cut back to a close, compact form. The pruning is always done in the fall or winter, and the last season's growth is cut back one-half. In cases where the tree is weak and straggling in growth, many of the large, long branches are cut back to give it good form.

The results of all of our experiments with plant life lead us to the belief, although it may not now be susceptible of positive proof, that the fungus growth generally found in diseased plants only develops after the tissues have become deranged or injured by some external cause, as cold following a season of immature growth, exhaustion caused by overbearing or drought, exhaustion of the soil, or injuries from insects.

In every instance where proper remedies have been applied *in time*, the trees have recovered and made a good growth.

The chemical side of these experiments will be fully given by Dr. Goessmann.

The questions of *pear blight* and *rust* on the blackberry and raspberry have received attention, but the results are not fully complete, and will be reserved for a future report.

VI. Destruction of Injurious Insects.

The work in this line has been confined to means of destruction of the currant worm (*Eufitchia riberia*); the cab-

bage worm (*Pieris rapæ*) ; the plum weevil, or plum curculio (*Conotrachelus nenuphar*) ; the Colorado potato beetle (*Dophora decem-lineata*) ; and the rose bug (*Macrodactylus subspinosa*).

The various insecticides used were powdered hellebore, pyrethrum powder, carbolate of lime, lime and kerosene, and lime and sulphur. The above were used in the dry form and in liquid.

The Currant Worm.

This worm is the larva of a moth about three-fourths of an inch across, which destroys the foliage soon after it unfolds, and again about the time the fruit begins to ripen. It was destroyed very quickly by the hellebore and pyrethrum. The latter, being more rapid in its action, and entirely free from poisonous qualities, can be used without danger at any time. The results of application of the other insecticides were not satisfactory, and further experiment as to their value must be made at some future time.

The Cabbage Worm.

The only effectual and easily applied remedy found for this insect was the pyrethrum powder. This applied dry destroyed the worms very quickly, even when mixed with five times its bulk of common plaster. It was applied by means of a pair of common sulphur bellows with a curved nose, a single movement of the bellows being sufficient to send the dust over all parts of the inside of the plant. Insecticides applied in liquids did not prove satisfactory, on account of the peculiar structure of the surface of the leaves of the cabbage, which causes the liquid to roll off in drops. This remedy proved most effectual when extended with an equal bulk of plaster.

Curculio, or Plum Weevil.

All the remedies applied for the destruction of this pest were ineffectual in saving a single specimen of fruit from some twenty trees that bloomed and set a large crop.

It is hoped, however, that by further experiments with the same remedies and other substances something may be found that will save this crop, either by being offensive to or by the destruction of the insects. In the meantime the certain but laborious method of jarring the trees and destroying the insects and the fruit containing their larvæ, or that of planting the trees in poultry yards, must be resorted to.

The Potato Beetle.

The effect of the pyrethrum powder on the larvæ of this beetle was to paralyze for a time, but not to kill them.

The Rose Bug.

This is another insect that our remedies, in a measure, failed to destroy or to prevent wholly from destroying the grape crop and rose blossoms. Pyrethrum has the effect of paralyzing them for a time, and by repeated applications, several times each day, may prove effectual.

Kerosene and lime, dry, seemed offensive to them, but they returned in a short time. Further experiments are required to fully determine its value.

In the use of carbolic acid, kerosene, and sulphur, they were slacked with caustic lime and applied in form of powder or in liquids.

The liquids used for the distribution of insecticides were water and buttermilk; the latter causing the substances to adhere to the foliage for a long time; in some cases three weeks or more.

An examination was made to determine the cause of the dropping of the apple crop, and it was found, in eight hundred specimens examined when from one-half of an inch to one inch in diameter, that all but three of this number were punctured, and contained one or more eggs or larvæ of the plum weevil, and only a very few contained the larvæ of the codling moth, which is so destructive later in the season.

VII. Germination of Weed Seeds.

Material for these experiments was collected during the summer and autumn, and arrangements are already made for

testing the germinating power of various kinds of seeds, especially troublesome weed seeds, at different stages of ripeness, and also under various conditions, the report of which will be made for one of the early monthly bulletins.

S. T. MAYNARD,

Professor of Botany and Horticulture,
Massachusetts Agricultural College.

ANNUAL REPORT OF THE CHEMIST.

I. Fodder and Fodder Analyses.

To ascertain the composition of our fodder articles, as far as the character and relative proportion of their essential proximate constituents are concerned, is the first step towards the introduction of a rational system of feeding our farm live stock.

A better knowledge of what we feed enables us to give a more judicious explanation of the results of our feeding experiments; it teaches best how to supplement our own fodder resources to meet the special wants of our farm stock, and cannot fail to direct the attention of the producer of fodder crops to the important question whether they are, as far as quality is concerned, what they ought to be. Actual feeding experiments have shown that the condition and quality of the soil exert a decided influence, not only on the quantity, but also on the quality of the crops raised upon it. For instance, oats raised during the same season upon the same kind of soil, with the aid of manures and without them, have been noticed to contain in the latter case as low as five, and in the former as high as eleven, per cent. of nitrogenous constituents in its dry vegetable matter.

The existence of similar relations between the particular condition of the soil and the composition of the crops, has been proved in regard to most of our prominent grasses and leguminous plants, as clover, as well as of mixed forage crops, like meadow hay.

A high percentage of nitrogenous constituents in these crops is usually accompanied by a high percentage of phosphoric acid compounds.

As both are known to exert a decidedly beneficial influence on the absolute and relative nutritive value of a single article of fodder, may it be an entire plant, or a particular part of it, it needs scarcely any farther argument to prove that an economical system of feeding our farm stock ought to begin with an intelligent cultivation of our leading fodder crops. We ought to raise them with a view to promote the special development of their most valuable nutritive constituents; and to select the crops for cultivation with reference to the particular adaptation of soil, climate and location *to favor the production of the best of its kind.* The introduction of a greater variety of fodder crops cannot fail to assist materially in gaining the desirable end. To raise good potatoes for family use, or good sugar-beets for the sugar manufacturer, requires a different condition of the soil, as far as the character of its accumulated plant-food is concerned, than to raise both crops of a superior quality for feeding purposes.

A mealy potato is usually rich in starch and, comparatively speaking, deficient in nitrogenous matter; and sugar-beets, best adapted for the manufacture of sugar, are rich in sugar, and contain a low percentage of nitrogenous constituents; they yield to the manufacturer the largest amount of sugar at the lowest expense.

The garden-farmer and manufacturer of sugar judge the quality of their respective crops by a standard quite different from that of the farmer who, engaged in general farming, considers stock-feeding an important part of his industry.

To compound an economical and suitable diet for any class of farm animals requires not only a general knowledge of the composition of the fodder on hand, but also a fair acquaintance with the relative proportion of the three groups of essential nutritive constituents they are apt to contain under different conditions of the soil. This kind of information is as essential for the guidance of the experimenter as the knowledge of the special wants of the animal with reference to its organization, age and functions. The wide range of variations in composition which has been noticed in our leading fodder crops when raised upon rich or ex-

hausted lands, renders many of our current tabular statements of the chemical composition of the more prominent articles of fodder of *doubtful merit in the hands of the farmer, who considers them an unfailing guide in his special case.*

The majority of these fodder tables may be traced to one source (E. Wolff). They state the mean of a smaller or larger number of analyses, quite frequently made without any intention to ascertain the possible variations in the composition of the article under investigation. The analytical statements themselves refer in the majority of cases to plants raised in Germany, and in other European countries. Whilst the great value of these Tables from an agricultural educational standpoint must be conceded, their analytical statements require qualification before they may be safely relied on in home practice. The Annual Report of the Secretary of the Massachusetts State Board of Agriculture for 1882, pages 104–114, contains a tabular statement of the composition of many fodder crops, giving the extremes (highest and lowest percentages found), with reference to each group of nutritive constituents. (Julius Kühn.)

This mode of stating the composition of the various farm crops tends to direct the attention more decidedly towards the advantages arising from a proper cultivation of fodder crops.

The Experiment Station has entered upon a systematic course of investigation to assist in determining the influence of stage of growth and of cultivation on the feeding value of some of our prominent forage plants.

The chemical analysis of any article of fodder begins usually with the determination of its moisture, and of the amount of *dry matter* left behind when heated to a temperature not exceeding 110° C., or 230° F., until a constant weight is obtained. The proximate constituents of the dry matter are subsequently reported with reference to the special relation they bear towards the support of animial life. Liebig's classification of the constituents of a complete animal food into *three distinct nutritive groups* of *compounds*, namely, nitrogen containing organic substances (*nitrogenous substances, crude protein*), non-nitrogenous, containing organic sub-

stances (carbo-hydrates) and mineral matter, is still recognized in the general arrangement of the analytical results of the examination. As more recent investigations have shown a superior physiological value of the fat,* — one of the non-nitrogenous constituents, — as compared with starch, sugar, and other representatives of that group, its amount is separately recorded. The same course, for similar reasons, has been of late adopted with reference to certain soluble forms of nitrogenous organic constituents of fodder articles.

In the subsequent analytical statements of examinations carried on at the Station, crude fat refers to the non-volatile residue of the ether abstract of the dried material; and crude protein refers to the nitrogen obtained by the soda lime test, multiplied by 6.25. The substances were in every case reduced to a uniform size, by passing them through a metal sieve, 144 mesh to the square inch.

The general course of analysis was the customary one, introduced by Henneberg and Stohman. Each analysis, as far as possible, is accompanied with a statement of the ratio of digestibility of the various groups of fodder constituents, ascertained in some well-conducted feeding experiments.

Records of this kind cannot fail to assist in forming a more intelligent opinion regarding the real nutritive portion of the fodder we feed.

* See, for details, "Influence of Chemistry on a Rational System of Stock Feeding," in the Thirtieth Annual Report of the Massachusetts State Board of Agriculture (1882–83), pages 89 to 125.

II. Analyses of Fodder.

DRIED FODDER CORN — (Frost-Bitten).

[From the Farm of the Experiment Station, 1883.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	8.83	176.6	–	–	1 : 9.82
Dry Matter,	91.17	1,823.4	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	4.86	92.7	–	–	
" Cellulose,	29.05	581.0	418.32	72	
" Fat,	2.06	41.2	30.90	75	
" Protein (Nitrogenous Matter),	8.63	172.6	126.00	73	
Non-nitrogenous Extract Matter,	55.40	1,108.0	742.36	67	
	100 00	2,000.0	1,317.58	–	

The sample was taken from unmanured fields, September 5, 1883, after a serious frost. The material for analysis was dried by artificial means. The bulk of the crop was put into a silo. The corn showed only the tassel, no silk having yet appeared. It was turned into ensilage at an earlier stage of growth than was originally intended. The dry matter contained in fodder corn, between showing the tassel and maturing the kernel, may vary from 12 to 18 per cent. and more.

CORN STOVER — (FROST-BITTEN).

[From Unmanured, Underdrained Plats of the Station.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	8.73	174.6	–	–	1 : 16.67
Dry Matter,	91.27	1,825.4	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	3.12	62.4	–	–	
" Cellulose,	34.28	685.6	356.51	52	
" Fat,	1.27	25.4	7.11	28	
" Protein (Nitrogenous Matter),	6.58	131.6	48.69	37	
Non-nitrogenous Extract Matter,	54.75	1,095.0	438.00	40	
	100.00	2,000.0	850.31	–	

The kernels were not fully matured in consequence of the frost.

FODDER CORN (1).

[Sent by THOMAS J. FIELD, Northfield, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	6.65	133.0	–	Not determined by actual feeding experiment.	–
Dry Matter,	93.35	1,867.0	–		–
	100.00	2,000.0	–		–
Analysis of Dry Matter.					
Crude Ash,	4.68	93.6	–		–
" Cellulose,	31.39	627.8	–		–
" Fat,	1.42	28.4	–		–
" Protein (Nitrogenous Matter),	6 83	136.6	–		–
Non-nitrogenous Extract Matter,	55.68	1,113.6	–		–
	100.00	2,000.0	–		–

FODDER CORN (2). — (FROST-BITTEN.)

[Sent by THOMAS J. FIELD, Northfield, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	6.67	133.4	–	–	–
Dry Matter,	93.33	1,866.6	–	–	–
	100.00	2,000.0	–	–	–
Analysis of Dry Matter.					
Crude Ash,	5.11	102.2	–	–	–
" Cellulose,	33.75	675.0	–	–	–
" Fat,	1.11	22.2	–	–	–
" Protein (Nitrogenous Matter),	6.17	123.4	–	–	–
Non-nitrogenous Extract Matter,	53.86	1,077.2	–	–	–
	100.00	2,000.0	–	–	–

The history of the above two samples of fodder corn, as far as their respective stages of growth and their mode of cultivation, etc., is concerned, has not been reported.

The analytical results show some difference in composition in favor of No. 1, yet hardly enough, under existing circumstances, to encourage a discussion of the effects of frost in this particular case. The sample of frost-bitten corn, after careful drying, proves still of a fair composition. The particular stage of growth and the character of the weather exert a controlling influence on the degree of changes in composition.

The effects of frost are usually more serious in the earlier periods of the life of the plants than in their more matured states. Dry, cool weather, after a frost, causes less alteration in composition than sultry, warm weather. Frost-bitten green fodder corn is best preserved in silos.

CORN-MEAL.

[Collected of CHAS. PARSONS, Northampton, Mass.]

93.25 parts passed through mesh, 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	17.04	340.80	–	–	1 : 5.54
Dry Matter,	82.96	1,659.20	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	1.58	31.60	–	–	
" Cellulose,	3.60	72.00	24.48	34	
" Fat,	4.82	96.40	73.26	76	
" Protein (Nitrogenous Matter),	16.80	336.00	285.60	85	
Non-nitrogenous Extract Matter,	73.20	1,464.00	1,376.16	94	
	100.00	2,000.00	1,759.50	–	

Essential Mineral Constituents in 100 Parts of Corn-meal.

Potassium oxide,	0.419
Calcium oxide,	0.040
Magnesium oxide,	0.176
Phosphoric acid,	0.644

The above rate of digestibility was found in feeding experiments with pigs.

CORN-MEAL.

[From JOHN L. HOLLEY, South Amherst, Mass.]

Ninety-two per cent. passed through mesh, 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	13.55	271.0	–	–	1 : 9.66
Dry Matter,	86.45	1,729.0	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	1.42	28.4	–	–	
" Cellulose,	2.64	52.8	17.95	34	
" Fat,	4.24	84.8	64.45	76	
" Protein (Nitrogenous Matter),	10.40	208.0	176.80	85	
Non-nitrogenous Extract Matter,	81.30	1,626.0	1,528.44	94	
	100.00	2,000.0	1,787.64	–	

The article is a fair specimen of its kind. As a more detailed discussion of the composition of corn may not be without some interest in this connection, I refer to the results of an examination of eleven prominent Eastern, Western, and Southern varieties, which have been published in the annual report of the Massachusetts State Board of Agriculture for 1879. The samples of corn which served for my investigation were furnished by well-known parties. The mode of cultivation and of manuring was stated, and the material had been collected with care. The analytical work was carried on with a view of securing results of a strictly comparative value. They were stated with reference to a corresponding amount of moisture, to render differences in composition prominent at sight. The actual demonstration of the influence of the particular condition of the soil on the feeding value of the same variety of corn raised upon it (independent of varying quantity) deserves a serious consideration.

CORN-MEAL AND COBS.

[Collected of CHAS. PARSONS, Northampton, Mass.]

78.63 per cent. passed through mesh of 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	19.07	381.40	–	Not determined by actual feeding experiment.	–
Dry Matter,	80.93	1,618.60	–		–
	100.00	2,000.00	–		–
Analysis of Dry Matter.					
Crude Ash,	1.61	32.20	–		–
" Cellulose,	9 77	195.40	–		–
" Fat,	3.43	68.60	–		–
" Protein (Nitrogenous Matter),	15.06	301.20	–		–
Non-nitrogenous Extract Matter,	70.13	1,402.60	–		–
	100.00	2,000.00	–		–

The rate of digestibility of corn cobs has been stated of late by E. Wolff as follows: 42 per cent. of protein, 52 per cent. of non-nitrogenous matter, and 30 per cent. of the fat. Whether these values are the results of actual feeding experiments, or an approximation by this distinguished author, I am not prepared to decide. There is but little doubt, however, that the addition of cobs to meal deserves recognition in regard to their nutritive value as well as to their beneficial mechanical influence upon the digestion of the corn-meal. For analysis of corn cobs, see report of Mass. Board of Agriculture for 1879, pages 240–244.

NEBRASKA RED CORN.

[Sent from Franklin County, Mass]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	10.74	214.8	–	–	1 : 6.97
Dry Matter,	89.26	1,785.2	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	1.44	28.8	–	–	
" Cellulose,	3.36	67.2	22.85	34	
" Fat,	6.05	121.0	91.96	76	
" Protein (Nitrogenous Matter),	14.16	283.2	240.72	85	
Non-nitrogenous Extract Matter,	74.99	1,499.8	1,424.81	95	
	100.00	2,000.0	1,780.34	–	

A comparison of the above stated analytical results, with those previously referred to, show a high nutritive value for the red variety. Whether this result is mainly due to a high state of fertilization of the soil which served for its production, or to an inherent superiority of this variety of corn, further observation can only decide.

HOMINY FEED.

[Chit and Soft Parts of the Kernel of the Corn, collected of J. A. SULLIVAN, Northampton, Mass.]

46.07 per cent. passed through mesh, 144 to square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	8.93	178.60	–	Not determined by feeding experiment.	–
Dry Matter,	91 07	1,821.40	–		–
	100.00	2,000.00	–		–
Analysis of Dry Matter.					
Crude Ash,	2.07	41.40	–		–
" Cellulose,	3.77	75 40	–		–
" Fat,	4.89	97.80	–		
" Protein (Nitrogenous Matter,	11.20	224.00	–		
Non-Nitrogenous Extract Matter,	78.07	1,561.40	–		–
	100.00	2,000.00	–		–

Essential Mineral Constituents in 100 parts of Hominy Feed.

Potassium oxide,	0.49	per cent.
Calcium oxide,	0.18	"
Magnesium oxide,	0 28	"
Phosphoric acid,	0.98	"

The rate of digestibility is probably similar to that of corn-meal.

GLUTEN MEAL (1).

[Refuse from Glucose Manufacture from Messrs. SUMNER CROSBY & SON, South Boston, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C., . . .	8.43	168.6	–	Not ascertained by actual experiment.	–
Dry Matter, ...	91.57	1,831.4	–		–
	100.00	2,000.0	–		–
Analysis of Dry Matter.					
Crude Ash,.	.64	12.8	–		–
" Cellulose, . . .	3.55	71.0	–		–
" Fat, ...	8.75	175.0	–		–
" Protein (Nitrogenous Matter, ...	38.22	764.4	–		–
Non-Nitrogenous Extract Matter, ...	48.84	976.8	–		–
	100.00	2,000.0	–		–

Essential Mineral Constituents in 100 parts of Gluten Meal.

Potassium oxide, ...	0.0564
Calcium oxide, ...	0.0582
Magnesium oxide, ...	0.0346
Phosphoric acid, ...	0.4512
Sulphuric acid, ...	0.0215

GLUTEN MEAL (2).

[Refuse from Glucose Manufacture sent by NEWTON & FULLER, Springfield, Mass.]

Eighty-three per cent. passed through mesh, 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C, ...	10.23	204.6	–	Not determined by actual experiment.	–
Dry Matter, ...	89.77	1,795.4	–		–
	100.00	2,000.0	–		–
Analysis of Dry Matter.					
Crude Ash, ...	.65	13.0	–		
" Cellulose, . . .	1.20	24.0	–		–
" Fat, ...	5.06	101.0	–		–
" Protein (Nitrogenous Matter, ...	33.56	671.4	–		–
Non-nitrogenous Extract Matter, ...	59.53	1,190.6	–		–
	100.00	2,000.0	–		

Both articles were of a good mechanical condition. A comparison of the first and second analysis shows that the latter contained 3 per cent. of fat and 5 per cent. of nitrogenous matter less than the former, whilst its soluble non-nitrogenous constituents exceed that of the former about 10 per cent. No free sulphuric acid was noticed in either case. The rich nitrogenous character of the "gluten meal" places it between the brans of our grains and the oil cakes, and alongside of our leguminous seeds, as beans, pease, etc. Its peculiarity, as compared with the above fodder articles, consists in the low percentage of mineral constituents, a point which requires a careful consideration in its application. It ought to be fed with coarse articles of fodder, rich in mineral matter.

HAY OF BLACK GRASS (1).

[The following six samples of hay were sent by the Secretary of the Rowley Farmers' Club, Rowley, Essex County, Mass., in April, 1883.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	10.22	204.40	–	Not ascertained by actual feeding experiment.	–
Dry Matter,	89.78	1,795.60	–		–
	100.00	2,000.00	–		–
Analysis of Dry Matter.					
Crude Ash,	8.63	172.6	–		–
" Cellulose,	24.78	495.6	–		–
" Fat,	1.52	30.4	–		–
" Protein (Nitrogenous Matter),	9.39	187.8	–		–
Non-nitrogenous Extract Matter,	55.68	1,113.6	–		–
	100.00	2,000.0	–		–

The grass was cut before blooming on the 24th of June, 1882; it would have matured, according to the letter of the secretary, by the 10th of July. The hay had been housed as soon as cured.

HAY OF BLACK GRASS (2).

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	13.15	263.0	–	Not ascertained by actual feeding experiment.	–
Dry Matter,	86.85	1,737.0	–		–
	100.00	2,000.0	–		–
Analysis of Dry Matter.					
Crude Ash,	6.50	130.0	–		–
" Cellulose,	23.66	573.2	–		–
" Fat,	1.20	24.0	–		–
" Protein (Nitrogenous Matter,	7.15	143.0	–		–
Non-nitrogenous Extract Matter,	61.49	1,129.8	–		–
	100.00	2,000.0	–		–

The grass which served for the production of hay No. 2 was cut when it began to look red, — approaching maturity, — July 24th, 1882, and was housed as soon as cured.

HAY OF HIGH MARSH GRASS (3).

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	11.05	221.0	–	–	–
Dry Matter,	88.95	1,779.0	–	–	–
	100.00	2,000.0	–	–	–
Analysis of Dry Matter.					
Crude Ash,	6.18	123.6	–	–	–
" Cellulose,	24.81	496.2	–	–	–
" Fat,	0.98	19.6	–	–	–
" Protein (Nitrogenous Matter),	6.14	122.8	–	–	–
Non-nitrogenous Extract Matter,	61.89	1,237.8	–	–	–
	100.00	2,000.0	–	–	–

The grass was cut in July, 1882, and stored when cured. No statement was made with reference to the particular stage of growth of the grass at the time of cutting.

HAY OF LOW MARSH GRASS (4).

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	10.97	219.4	–	Not ascertained by actual feeding experiment.	–
Dry Matter,	89.03	1,780.6	–		–
	100.00	2,000.0	–		–
Analysis of Dry Matter.					
Crude Ash,	8.19	163.8	–		–
" Cellulose,	28.82	576 4	–		–
" Fat,	2.22	44.4	–		–
" Protein (Nitrogenous Matter),	6.79	135.8	–		–
Non-nitrogenous Extract Matter,	53.98	1,079.6	–		–
	100.00	2,000.0	–		–

The grass was cut in August, 1882, and stacked as soon as cured.

HAY OF LOW MARSH GRASS (5).

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	10.25	205.0	–	Not ascertained by actual feeding experiment.	–
Dry Matter,	89 75	1,795.0	–		–
	100.00	2,000.0	–		–
Analysis of Dry Matter.					
Crude Ash,	5 42	108.4	–		–
" Cellulose,	26.00	520.0	–		–
" Fat,	2.63	52.6	–		–
" Protein (Nitrogenous Matter),	7.19	143.8	–		–
Non-nitrogenous Extract Matter,	58.76	1,175.2	–		–
	100.00	2,000.0	–		–

The grass was cut in the middle of August, and housed as soon as cured.

HAY OF LOW MARSH GRASS (6)

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C., . . .	13.30	266.0	–	Not ascertained by actual feeding experiment.	–
Dry Matter, ...	86.70	1,734.0	–		–
	100.00	2,000.0	–		–
Analysis of Dry Matter.					
Crude Ash, ...	6.05	121.0	–		–
" Cellulose, . . .	27.19	543.8	–		–
" Fat, ...	2.90	58.0	–		–
" Protein (Nitrogenous Matter), . . .	7.17	143.4	–		–
Non-nitrogenous Extract Matter, ...	56 69	1,133.8	–		–
	100.00	2,000.0	–		–

The grass was cut September 9th, and stacked when cured. It was injured somewhat by rain, and by the sea water.

Analysis of Dry Matter of the Hays sent on by the Rowley Farmers' Club, and of an Average Quality of good Inland Meadow Hay.

	Hay of Black Grass, No. One.	Hay of Black Grass, No. Two.	Hay of High Marsh Grass, No. Three.	Hay of Low Marsh Grass, No. Four.	Hay of Low Marsh Grass, No. Five.	Hay of Low Marsh Grass, No. Six.	Hay of genuine Grasses in Full Blossom (H. Weiske).
Crude Ash,	8.63	6.50	6.18	8.19	5.42	6.05	8.55
" Cellulose,	24.78	23.66	24.81	28.82	26.00	27.19	27.61
" Fat,	1.52	1.20	0 98	2.22	2.63	2.90	5.02
" Protein (Nitrogenous Matter),	9.39	7.15	6.14	6.79	7.19	7 17	12.69
Non-nitrogenous Extract Matter,	55.68	61.49	61.89	53.98	58.76	56.69	46.13
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The various samples of marsh or "salt hay," which served for the above analyses, were supplied by different members of the club; they arrived in good condition, and had evidently been collected with care. The individual plants, however, were in a condition which did not allow a satisfactory determination of their botanical names, and of the relative proportion of the various kinds of plants present, nor of their particular stage of growth. The communication received from the secretary of the club has to furnish, for this reason, the basis for a few subsequent remarks. A small collection of the upper portion of marsh meadow plants, neatly fastened upon suitable paper, accompanied the hay samples. To each specimen of this collection was attached its local name, with some general remarks as follows: —

"No. 1, — Sedge grass, grows on low spots.
"No. 2, — Branch grass.
"No. 3, — Goose grass, stalks with seeds.
"No. 4, — Fox, or red grass, the most common salt grass.
"No. 5, — Marsh mallows, called by some rosemary.

"These varieties of plants are generally found more or less mixed in all salt marshes. On marshes that have been ditched, a grass called white-top — by some called red-top — comes in and grows together with the above-stated fox grass. This white-top is nearly as early as 'black grass,' which is one of our earliest grasses, and the only one which grows distinct by itself."

As grass, like "rushes" and "sedges," exerts a controlling influence on the local character, and thus the comparative feeding value of the hay obtained from different places, it has to be conceded that the absence of a more detailed information regarding the particular character and condition of the vegetation, etc., which served for the production of the above-described hay samples, imparts to our analytical results in the majority of cases (from three to six) a mere local interest. A comparison of the various samples seems to confirm the prevailing impression that the "black grass" (*Juncus bulbosus*) furnishes a valuable fodder; and that

carefully secured marsh hay in many instances, as far as composition is concerned, compares favorably with a large proportion of hay from "inland" meadows. There is scarcely another fodder crop on record of which the feeding value depends so much on a judicious management of the farmer as in the case of hay.

The first requirement for an intelligent examination concerning the comparative value of a fodder plant, or part of a plant, consists in securing specimens of a corresponding stage of growth. Adding to this a due consideration of the various circumstances under which the plants under examination are raised, results are attainable which may claim a general interest.

I take the liberty of suggesting, in this connection, to communicate rather with the officer in charge of the Station, before sending material of a similar character, and of asking an investigation of a subject of similar importance. The best interest of the farmers and of the Station will be served by adopting that course.

The fact that our opinion regarding the actual and relative feeding value of many of our fodder crops is still largely based on mere chance analyses, instead of on a systematic inquiry regarding our chances of securing the best results, is one of the principal impediments of arriving at a more settled opinion regarding a more rational management of feeding our farm live stock.

HAY OF WINTER RYE.

[Sent by John E. Russell, Secretary of Massachusetts Board of Agriculture.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	8.55	171.0	–	–	1 : 8.28
Dry Matter,	91.45	1,829.0	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	6.40	128.0	–	–	
" Cellulose,	32.97	659.4	–	–	
" Fat,	2.57	51.4	23.65	46	
" Protein (Nitrogenous Matter),	10.66	213.2	121.52	57	
Non-nitrogenous Extract Matter,	47.40	948.0	948.00	100	
	100.00	2,000.0	1,093.17	–	

The sample was cut May 25, 1883, when in full blossom. It is of a fair quality, and compares well with a medium good quality of meadow hay. The ratio of digestibility stated in connection with the non-nitrogenous extract matter of the hay, includes that of the crude cellulose, or raw fibre.

Green winter rye in blossom may contain from 20 to 26 per cent. of vegetable matter, and from 80 to 74 per cent. of water.

TIMOTHY HAY.

[From the Experimental Farm]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	8.70	174.0	–	–	–
Dry Matter,	91.30	1,826.0	–	–	–
	100.00	2,000.0	–	–	–
Analysis of Dry Matter.					
Crude Ash,	4.04	80.8	–	–	–
" Cellulose,	36.59	731 8	–	–	–
" Fat,	2.12	42.4	–	–	–
" Protein (Nitrogenous Matter),	7.24	144.8	–	–	–
Non - nitrogenous Extract Matter,	50 01	1,000.2	–	–	–
	100.00	2,000.0	–	–	–

The hay was harvested in July, after blooming. The sample was taken from the barn in November.

HAY OF RIPE OATS.

[From the Experimental Farm.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	8.70	174.0	–	–	–
Dry Matter,	91.30	1,826.0	–	–	–
	100.00	2,000.0	–	–	–
Analysis of Dry Matter.					
Crude Ash,	6.11	122.2	–	–	–
" Cellulose,	36.31	726.2	–	–	–
" Fat,	2.61	52.2	–	–	–
" Protein (Nitrogenous Matter),	6.05	121.0	–	–	–
Non - nitrogenous Extract Matter,	48.92	978.4	–	–	–
	100.00	2,000.0	–	–	–

The material for analysis consisted of the entire matured plant, and was collected August 26, 1883.

HAY OF OATS.

[From one of the Experimental Plats of the Station.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	6.43	128.6	–	–	1 : 14.24
Dry Matter,	93.57	1,871.4	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	6.41	128.2	–	–	
" Cellulose,	34.06	681.2	–	–	
" Fat,	2.92	58.4	26.86	46	
" Protein (Nitrogenous Matter),	6.58	131.6	75.01	57	
Non-nitrogenous Extract Matter,	50.03	1,000.6	1,000.60	100	
	100.00	2,000.0	1,102.47	–	

The sample was collected August 1, 1883, when in full blossom. It contained 74 per cent. of moisture, and 26 per cent. of dry matter. Its composition as shown by analysis can scarcely be called a fair one. The dry matter of oats in blossom may vary from 15 to 26 per cent.

Actual feeding experiments have shown that the condition and quality of the soil, aside from season and climate, exert a decided influence not only on the quantity, but also upon the quality of the crops raised upon it.

The analyses of our rye, oats and timothy previously described, were made with a view to ascertain the condition of the land which has passed under the control of the Station.

RYE BRAN.

[Collected of Chas. Parsons, Northampton, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	13.70	274.00	–	–	
Dry Matter,	86.30	1,726.00	–	–	
	100.00	2,000.00	–	–	
Analyis of Dry Matter.					
Crude Ash,	5.17	103.40	–	–	1 : 4.39
" Cellulose,	4.54	90.80	8.17	9.	
" Fat,	2.07	41.40	23.80	57.5	
" Protein (Nitrogenous Matter),	18 98	379.60	250.54	66.	
Non-nitrogenous Extract Matter,	69.24	1,384.80	1,031.68	74.5	
	100.00	2,000.00	1,314.19	–	

The above ratio of digestibility of the various constituents was ascertained in feeding experiments with pigs.

WHEAT BRAN.

[Collected of Chas. Parsons, Northampton, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	13.70	274.00	–	–	
Dry Matter,	86.30	1,726.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	6.76	135.20	–	–	1 : 3.30
" Cellulose,	9.33	186.60	37.32	20	
" Fat,	2.91	58.20	46.56	80	
" Protein (Nitrogenons Matter),	19.56	391.20	344.26	88	
Non-nitrogenous Extract Matter,	61 44	1,228.80	983.04	80	
	100.00	2,000.00	1,411.18	–	

The above rate of digestibility was ascertained by feeding the dry material to steers.

WHEAT BRAN.

[From JOHN L. HOLLEY, South Amherst, Mass.]

Thirty-three per cent. passed through mesh, 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	12.08	241.6	–	–	1 : 4.16.
Dry Matter,	87.92	1,758.4	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	7.92	158.4	–	–	
" Cellulose,	13.72	274.4	54.88	20	
" Fat,	3.81	76.2	60.96	80	
" Protein (Nitrogenous Matter),	15.67	313.4	275.79	88	
Non-nitrogenous Extract Matter,	58.88	1,177.6	942.08	80	
	100.00	2,000.0	–	–	

The article is of a fair composition.

LINSEED CAKE.

[From Indiana.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C,	8.35	167.00	–	–	1 : 1.62
Dry Matter,	91.65	1,833.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	7.52	150.40	–	–	
" Cellulose,	8.69	173.80	45.19	26	
" Fat,	5.69	113.80	103.56	91	
" Protein (Nitrogenous Matter),	37.25	745.00	648.15	87	
Non-nitrogenous Extract Matter,	40.85	817.00	743.47	91	
	100.00	2,000.00	1,540.37	–	

Essential Mineral Constituents in 100 parts Linseed Cake.

Potassium oxide,	1.43	per cent.
Calcium oxide,	0.64	"
Magnesium oxide,	0.77	"
Phosphoric acid,	1.86	"

The stated ratio of digestibility was ascertained by feeding experiments with steers.

COTTON-SEED MEAL.

[Collected of Charles Parsons, Northampton, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	9.13	182 60	–	–	1 : 1.23
Dry Matter,	90.87	1,817.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	7.61	152.20	–	–	
" Cellulose,	6.28	125.60	28.89	23	
" Fat,	12.83	256.60	233.51	91	
" Protein (Nitrogenous Matter),	47.04	940.80	696.19	74	
Non-nitrogenous Extract Matter,	26.24	524.80	241.41	46	
	100.00	2,000.00	1,200.00	–	

The percentage of nitrogenous constituents is exceptionally high.

The above rate of digestibility is based on experiments with sheep.

COTTON-SEED MEAL.

[From JOHN L. HOLLEY, South Amherst, Mass.]

Eighty-nine per cent. passed through mesh, 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C., . .	8 38	167.6	–	–	1 : 1.41
Dry Matter, ...	91.62	1,832.4	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash, ...	8.51	170.2	–	–	
" Cellulose, . . .	6.73	134.6	30 82	23	
" Fat, ...	12.94	258.8	235 51	91	
" Protein (Nitrogenous Matter), . . .	42.47	849.4	628.56	74	
Non - nitrogenous Extract Matter, ...	29.35	587.0	270.02	46	
	100.00	2,000.50	1,164.91		

A very good article as far as composition and mechanical conditions are concerned.

COTTON-SEED MEAL (1).

[Sent by J. E. SOPER & Co., Boston.]

Eighty-six per cent. passed through mesh, 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C., . .	7.10	142.0	–	–	1 : 1.44
Dry Matter, ...	92.90	1,858 0	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash, ...	9.34	186.8	–	–	
" Cellulose, . . .	7.53	150 6	34.63	23	
" Fat, ...	13.75	275.0	250.25	91	
" Protein (Nitrogenous Matter), . . .	42.58	851.6	630.18	74	
Non - nitrogenous Extract Matter, ...	26.80	536.0	246.56	46	
	100.00	2,000.0	1,161.62	–	

The composition of the above article does not materially differ from previous analyses; the variations are within the limits noticed in fair samples of cotton-seed meal. Its mechanical condition was of a superior character. The meal was produced, according to the statement of the dealer, by a new process, "Roller-Process," and sifted.

COTTON-SEED MEAL (2).

[Sent by J. E. Soper & Co., Boston.]

Eighty-one per cent. passed through mesh, 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	8.15	163.0	–	–	1 : 1.88
Dry Matter,	91.85	1,837.0	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	7.46	149.2	–	–	
" Cellulose,	7.41	148.2	34.09	23	
" Fat,	14.72	294.4	267.90	91	
" Protein (Nitrogenous Matter),	36.54	730.8	540.79	74	
Non-nitrogenous Extract Matter,	33.87	677.4	311.60	46	
	100.00	2,000.0	1,154.38	–	

The article was obtained by the old (press) process. The sample which served for analysis (1) was of a better mechanical condition than (2). A comparison of samples (1) and (2) show their difference, due rather to the fact that different lots of cotton-seed served for the production of the article tested, than to a different process of grinding. The two modes of producing cotton-seed meal ought to be tried on the same lot of seeds, to render their respective merits conspicuous.

COTTON-SEED MEAL.

[Sent by E. S. WARNER, Hatfield, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C.,	7.09	141.8	–	–	
Dry Matter,	92.91	1,858.2	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	9.15	183.0	–	–	
" Cellulose,	10.53	210.6	48.44	23	1 : 1.46
" Fat,	13.65	273.0	248.43	91	
" Protein (Nitrogenous Matter),	41.64	832.8	616.27	74	
Non-nitrogenous Extract Matter,	25.03	500.6	230.28	46	
	100.00	2,000.0	1,143.42	–	

The article is of good quality, and was obtained by bolting a coarse cotton-seed meal. Eighty-one pounds of the above was obtained from one hundred pounds of the latter. The coarse portion — nineteen per cent. — has been analyzed to ascertain its fitness as a fertilizer with the following results : —

Coarse portion of Cotton-Seed Meal for fertilizing purposes.

(Sent by E. S. Warner, Hatfield, Mass.)

	Per cent.
Moisture, at 100° C.,	7.09
Organic and volatile matter,	93 465
Ash constituents,	6.535
	100.000

	Per cent.
Nitrogen in organic compounds,	5.900
Potassium oxide,	1.797
Calcium oxide,	0.263
Magnesium oxide,	0.223
Phosphoric acid,	2.341
Insoluble matter,	1 784

Valuation per ton of two thousand pounds:—

118 pounds of nitrogen, at 18 cents, ...	$21 24
46.82 pounds of phosphoric acid, at 6 cents, . . .	2 69
35.94 pounds of potassium oxide, at 4¼ cents, . .	1 53
	$25 46

COCOA DUST.

[Refuse from Cocoa Manufacture, sent from Boston, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a Ton of 2,000 lbs.	Pounds Digestible in a Ton of 2,000 lbs.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture, at 100° C., . .	7.10	142.0	–	Not determined by actual experiment.	–
Dry Matter, ...	92.90	1,858.0	–		–
	100.00	2,000.0	–		–
Analysis of Dry Matter.					
Crude Ash, ...	6 83	136.6	–		–
" Cellulose, . . .	5.86	117.2	–		–
" Fat, ...	25.85	517.0	–		–
" Protein (Nitrogenous Matter), . . .	15.47	309.4	–		–
Non-nitrogenous Extract Matter, ...	45.99	919 8	–		–
	100.00	2,000.0	–		–

Essential Mineral Constituents in 100 Parts of Cocoa Dust.

Potassium oxide, ...	2.11
Calcium oxide, ...	.63
Magnesium oxide, ...	traces
Phosphoric acid, ...	1.34

The material consisted of the inside and outside parts of the cocoa bean, with some foreign matter. It was obtained in the process of cracking and sifting the bean. The examination was made by request, to ascertain its fitness for manuring. Although its nitrogen percentage (2.3 per cent.) compares well with many fertilizers in our market, it would be, for economical considerations, more advisable to try the cocoa dust as a fodder in place of oil-bearing seeds. The reputation of the cocoa as a highly nutritive food for man is too well established to doubt the efficiency of the above described article as a fodder for some kind of farm stock.

III. — Miscellaneous Analyses.

EXAMINATIONS OF SKIM MILK FOR FAT.

[Samples sent on at different times for examination.]

	Sample Numbers.									
	1	2	3	4	5	6	7	8	9	10
Amount of fat in 100 parts, . . .	.26	.31	.38	.30	.38	.37	.35	.48	.54	.48

Analysis of Milk from Shorthorn Cow.

	Per cent.
Moisture, at 100° C., ...	88.45
Solid matter, ...	11.55
	100.00
Ash percentage, ...	0.72

One hundred parts of ash contained —

	Per cent.
Potassium oxide, ...	23.52
Sodium oxide, ...	14.20
Calcium oxide, ...	23.11
Magnesium oxide, ...	2.52
Phosphoric acid, ...	30.59

Animal had been fed largely with roots; milk yielded its butter slowly.

Analysis of Onions.

Air dry without leaves —

	Per cent.
Moisture, at 100° C., ...	89.20
Dry matter, ...	10.80

Dry matter contained of —

	Per cent.
Nitrogen, ...	2.12
Sulphur, ...	.48
Ash constituents, ...	4.36

One hundred parts of ash contained —

	Per cent.
Potassium oxide, ...	38.51
Sodium oxide, ...	1.90
Calcium oxide, ...	8.20
Magnesium oxide, ...	3.65
Sequioxide of iron, ...	.58
Silicic acid, ...	3.33
Phosphoric acid, ...	15.80
Sulphuric acid, ...	Not determined.

Analyses of Drainage Waters of Experimental Plats.

	Plats No.	Parts Per Million. Free Ammonia.	Albuminoid Ammonia.	Total Ammonia.	Nitrogen as Ammonia.	Nitric Acid.	Nitrogenous Nitrates.	Calcium Carbonate (Hardness).	Grains Per Gallon. Solids.	Potassium Oxide.	Phosphoric Acid.*	Clorine.
11 A. M., ...	0	.13	.09	.22	.18	3.15	.70	27.3	7.5	.18	–	.4
2.30 P. M., ...	0	.11	.06	.17	.14	–	–	16.9	5.	.15	–	.4
2.30 "	1	.08	.11	.19	.16	73.19	16.26	†	†	†	†	†
11 A. M, ...	3	.01	.07	.08	.07	1.20	.27	28.6	4.5	.13	–	.5
2.30 P M., ...	3	.45	.06	.51	.42	.83	.19	19.5	2.5	.13	–	.3
2.30 "	5	.02	.07	.09	.07	–	–	23.4	2.5	.11	–	.3
2.30 "	7	.01	.10	.11	.09	.22	.05	27.3	4.5	.18	–	.3
2.30 "	9	.02	.09	.11	.09	.28	.06	23.4	3.5	.14	–	.4
2 "	11	.01	.10	.11	.09	.41	.09	22.1	4.	.09	–	.2
11 A. M., ...	13	.01	.08	.09	.07	.78	.17	22.1	4.	.12	–	.3
2 P. M., ...	13	.01	.10	.11	.09	.59	.13	20.8	3.8	.21	–	.3
2 "	15	.01	.07	.08	.07	.13	.03	26.	4.5	.04	–	.3
2 "	17	.01	.10	.11	.09	.22	.05	45.7	9.	.07	–	.3
2 "	19	.01	.12	.13	.11	.78	.17	41.6	9.	.31	–	.4
11 A. M., ...	B	.01	.12	.13	.11	.69	.14	18.2	2.3	.07	–	.5
2 P. M., ...	B	.01	.15	.16	.13	–	–	15.6	13.3	.04	–	.4
2.30 "	C	.01	.11	.12	.10	.32	.07	18.2	2.5	.03	–	.3

* Trace. † Not determined.

IV. Valuation of Fertilizers and Fertilizer Analyses.

The valuation of commercial fertilizers is based on the market value of their essential constituents. The market reports of New York and Boston, aside from consultations with leading manufacturers of fertilizers, furnish us the necessary information.

The statements of trade values adopted in the reports are obtained by taking the average of New York and Boston wholesale quotations of the six months preceding March 1, 1883, and increasing them by 20 per cent. to cover expenses for storage, sales, etc.

The prices stated in connection with analyses of commercial fertilizers refer, therefore, to their cost per ton of 2,000 pounds, on board of car or boat.

Crude stock for the manufacture of fertilizers, and refuse material of various descriptions, sent to the Station for examination, are valued with reference to the market prices of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

The *mechanical condition* of any fertilizing material, simple or compound, deserves the most serious consideration of farmers when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant-food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value, in case of one and the same kind of substance. Two samples of fish fertilizer, although equally pure, may differ from 50 to 100 per cent. in commercial value on account of mere difference in moisture.

As existing laws of the State for control of the trade in commercial fertilizers provides for the examination of licensed articles, the attention of the Station has been directed mainly towards the examination of agricultural chemicals, the crude stock for the manufacture of commer-

cial fertilizers, and of prominent refuse materials from manufacturing industries and elsewhere.

The work has been carried on for the purpose of aiding the farming community in a clear and intelligent appreciation of these substances for manurial purposes.

General experience in farm practice teaches that it is safer, for economical reasons, to use commercial fertilizers rather as supplements than as substitutes for barn-yard manures.

The advantages arising from the introduction of chemical and commercial manurial substances can only be secured to their full extent when applied with reference to actual local wants of the soil, and to special requirements of the crops under cultivation.

A large percentage of commercial manurial material consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industry is liable to affect at any time, more or less seriously, the composition of the refuse. A constant inquiry into the character of the agricultural chemicals, and of commercial manurial refuse substances offered for sale, cannot fail to secure confidence in their composition, and diminish financial disappointment in consequence of their application.

Trade Values Adopted for 1883.

	Cents per lb.
Nitrogen in nitrates,	20
Nitrogen in ammonia salts,	26
Nitrogen in Peruvian guano, fine steamed bone, dried and fine ground blood, meat and fish, superphosphates and special manures,	23
Nitrogen in coarse or moist blood, meat, or tankage, in cotton-seed, linseed, and castor pumice,	18
Nitrogen in fine ground bone, horn, and wool dust,	17
Nitrogen in fine medium bone,	15
Nitrogen in medium bone,	14
Nitrogen in coarse medium bone,	13
Nitrogen in coarse bone, horn shavings, hair, and fish scrap,	11
Phosphoric acid, soluble in water,	11
Phosphoric acid, "reverted," and in Peruvian guano,	8
Phosphoric acid, insoluble, in fine bone, fish guano, and superphosphates,	6

	Cents per lb.
Phosphoric acid, insoluble, in fine medium bone,	5½
Phosphoric acid, insoluble, in medium bone,	5
Phosphoric acid, insoluble, in coarse medium bone,	4½
Phosphoric acid, insoluble, in coarse bone, bone ash, and bone black,	4
Phosphoric acid, insoluble, in fine ground rock phosphate,	2.75
Potash, in high grade sulphate,	7
Potash, in low grade sulphate and kainite,	4¼
Potash, in muriate or potassium chloride,	4¼

V. Fertilizer Analyses.

Dry Ground Fish.

(Sent from South Hadley Falls, Mass.)

Moisture, at 100° C.,	10.38
Total phosphoric acid,	6.00
Soluble phosphoric acid, } Reverted phosphoric acid, }	2.82
Insoluble phosphoric acid,	3.18
Nitrogen,	6.13

Valuation per two thousand pounds, $36.53.

Castor Pumice.

(Collected of D. A. Horton, Northampton, Mass.)

Moisture, at 100 C.,	10.18
Total phosphoric acid,	2.13
Nitrogen (18 cents per pound),	5.69
Potassium oxide,	0.92

Valuation per two thousand pounds, $23.84.

1. Dry Fish, sent by Franklin Farmers' Club.
2. Dry Fish, sent by Milo L. Smith, Smith's Ferry, Mass.
3. Half-dry Dog Fish Pumice, sent on from Portsmouth, R. I.

	Pounds per Hundred.		
	1	2	3
Moisture, at 100° C.,	6.61	7.50	11.35
Total Phosphoric Acid,	6.17	7.67	5.85
Soluble " " }	2.40	2.32	.66
Reverted, " " }			2.20
Insoluble, " "	3.77	5.35	2.99
Nitrogen,	8.47	9.36	6.96
Valuation per two thousand tons,	$47 32	$53 18	$40 58

Nova Scotia Plaster (Gypsum.)

(Collected of D. A. Horton, Northampton, Mass.)

	Per cent.
Moisture, at 100° C.,	15.79
Calcium oxide,	34.29
Magnesium oxide,	0.36
Sulphuric acid,	47.14
Insoluble matter,	1.42
Carbonic acid,	Not determined.

This gypsum contained a few per cent. of calcium and magnesium carbonates, which not unfrequently are associated with it.

"Orchilla" Guano.

(Collected of D. A. Horton, Northampton, Mass.)

	Per cent.
Moisture, at 100° C.,	11.05
Magnesium oxide,	4.13
Calcium oxide,	38.24
Phosphoric acid,	21.69
Insoluble matter,	0.17

The "Orchilla" guano belongs to a class of natural phosphates which are noted for their deficiency in organic and nitrogenous matter, as well as for their large percentage of carbonate of lime. The above described sample contained 47.39 per cent. of bone phosphate, and 22.39 per cent. of carbonate of lime. The presence of so large a percentage of the latter compound renders this material, from an economical standpoint, unsuitable for the manufacturers of superphosphate of lime. The natural pulverent condition of the ommercial article has favored its introduction into agricultural practice. Very satisfactory results are reported from its application in case of moist pastures and meadows, and of turfy soils. Upon a dry soil and in a dry season its action can be but slow. The safest way to secure an economical return seems to be a direct introduction in the daily product of stable manure, on account of the beneficial action of the fermenting animal excretions on the disintegration of the guano, and thus an increased solubility of its bone phosphate. Four cents per pound for phosphoric acid might be considered a safe investment. At that rate of valuation the above article would be worth $18 per ton of two thousand pounds.

Fish Pumice.

(Collected of H. L. Phelps, Northampton, Mass.)

	Per cent.
Moisture, at 100° C.,	44.41
Total phosphoric acid,	5.85
Soluble phosphoric acid,	1.57
Reverted phosphoric acid,	0.62
Insoluble phosphoric acid,	3.62
Nitrogen,	5.27

Valuation per two thousand pounds, $33.02

CANADA WOOD ASHES.

1. Sent from Sunderland, Mass.
2. Sent from Sunderland, Mass.
3. Sent from North Amherst, Mass.
4. Collected in Railroad Depot, Amherst, Mass.
5. Sent on from North Amherst, Mass.
6. Collected of D. A. Horton, Northampton, Mass.
7. White Ash, sent on from South Deerfield, Mass.

	Pounds per Hundred.						
	1	2	3	4	5	6	7
Moisture, at 100° C.,	24.50	16.66	18.70	9.30	8.40	16.70	6.62
Calcium Oxide,	33.19	32.25	30.60	34.91	39.71	35.26	50.89
Potassium Oxide,	4.77	4.97	4.61	6.50	4.96	5.55	5.23
Phosphoric Acid,	1.49	1.66	1.10	.78	.80	2.28	1.29
Insoluble Matter,	8.50	10.45	11.06	9.30	6.70	4.90	4.87

Samples 1, 2, 3, 4, 5, 6 represent the average quality of Canada wood ashes sold in our section of the Connecticut valley, at from 33 to 35 cents per bushel. Sample 7 was of an exceptional light color, and contained a larger per cent. of lime, yet compared well otherwise in composition with the others. The increasing importation of Canada ashes into various parts of the States renders it advisable to insist hereafter upon guaranteed analyses as the basis of commercial transactions.

The universal high opinion of wood ashes as a fertilizer does not depend merely upon a fair percentage of potash, but also on the presence of more or less of *all the various mineral elements essential to the growth of plants.*

Wood ashes, like barn-yard manure, on account of their compound character, meet, to some extent at least, not only known but unknown deficiencies in valuable soil constituents. The thorough mixture of their various constituents has, no doubt, a beneficial influence on their action.

8. Light-colored unleached ashes, sent by Secretary of South Deerfield Farmers Club. One bushel weighed forty-four pounds, and half pound of coarse material was removed before taking the sample for analysis.

9. Dark unleached ashes, sent by Secretary of South Deerfield Farmers' Club. One bushel weighed forty-six pounds, and two and a half pounds of coarse material was removed before taking the sample for analysis.

10. Dark unleached ashes, sent by Secretary of South Deerfield Farmers' Club. One bushel weighed forty-one pounds, and five pounds of coarse material were removed before taking the sample.

11. Collected on board cars at railroad depot, South Deerfield, Mass.

12. Collected on board cars at railroad depot, South Deerfield, Mass.

13. Collected of Mr. Almon Cowles, on board of cars, at North Amherst, Mass.

	Pounds per Hundred.					
	8		10	11	12	13
Moisture, at 100 C.,	0.70	16.98	10.28	8.33	1.03	10.01
Calcium Oxide,	50.51	36.11	32.83	45.00	50.02	35.67
Potassium Oxide,	7.38	4.90	6.10	5.91	6.94	7.19
Phosphoric Acid,	0.51	1.41	1.59	0.74	0.29	1 28
Insoluble Matter,	2.10	8.05	13.65	3.88	2.28	6.27

Nitrate of Soda.

(Collected of D. A. Horton, Northampton, Mass.)

	Per cent.
Moisture, at 100° C.,	1.25
Nitrogen,	15.57
Insoluble matter,	0.45

Valuation per two thousand pounds, $62.28

Muriate of Potash.

(Collected of George P. Smith, Sunderland, Mass.)

	Per cent.
Moisture, at 100° C.,	2.85
Potassium oxide,	50.59
Sodium oxide,	8.40
Magnesium oxide,	trace.
Sulphuric acid,	trace.
Insoluble matter,	1.50

(2. Collected of E. T. Sabin, East Amherst, Mass.)

	Per cent
Moisture, at 100° C.,	2.89
Potassium oxide,	50.05
Sodium oxide,	8 30
Magnesium oxide,	0.60
Sulphuric acid,	0.28
Insoluble matter,	0 15

Valuation per two thousand pounds, $42.54.

This form of "German Potash Salts" has thus far proved a very reliable source of potassa for general agricultural purposes; an extensive application has caused, of late, some advance in its cost, as compared with previous years.

Ammonium Sulphate.

(Collected of Geo. P. Smith, Sunderland, Mass.)

	Per cent.
Moisture, at 100° C.,	0.23
Ammonia (equivalent to nitrogen 20.4),	24.80
Sulphuric acid,	61.60
Insoluble matter,	0.05

Valuation per two thousand pounds, $106.08.

Peruvian Guano.

(Collected of D. A. Horton, Northampton, Mass.)

	Per cent.
Moisture, at 100° C.,	14.00
Total phosphoric acid,	20.60
Soluble phosphoric acid,	3.10
Reverted phosphoric acid,	1.55
Insoluble phosphoric acid,	15.95
Potassium oxide,	1.14
Nitrogen in organic matter,	1.40
Nitrogen in ammonia salts,	3.04

Valuation per two thousand pounds, $51.66.

Tankage.

(Sent from Chicago, Ill.)

	Per cent.
Moisture, at 100° C.,	6.10
Total phosphoric acid,	12.32
Soluble phosphoric acid,	0.27

	Per cent.
Reverted phosphoric acid,	3.25
Insoluble phosphoric acid,	8.79
Nitrogen,	6.57
Insoluble matter,	0.77

Florida Marl.

(Sent from Boston, Mass.)

	Per cent.
Moisture, at 100° C.	0.60
Calcium oxide,	41.75
Magnesium oxide,	1.03
Ferric oxide,	0.36
Phosphoric acid,	2.72
Insoluble matter,	21.95

Sponge Refuse.

(Sent from Albany, N. Y.)

	Per cent.
Moisture, at 100° C.,	7.25
Nitrogen,	2.43
Ferric oxide,	0.17
Calcium oxide,	3.94
Magnesium oxide,	1 27
Phosphoric acid,	3.19
Insoluble matter,	39.05

Bones.

(Pure Dissolved Raw Bones. Sent from Amherst, Mass.)

	Per cent.
Moisture, at 100° C.,	10.23
Total phosphoric acid,	16.03
Soluble phosphoric acid,	7.76
Reverted phosphoric acid,	3.83
Insoluble phosphoric acid,	4.44
Nitrogen,	2.64

Valuation per two thousand pounds, $40.67.

Fine Ground Raw Bone.

(Sent on from Worcester, Mass.)

	Per cent.
Moisture, at 100° C.,	4.63
Total phosphoric acid,	22.41
Nitrogen,	3.69

Valuation per two thousand pounds, $43.86.

1. Bone Fertilizers. Sent by John Sanborn, Lawrence, Mass.
2. Pure Fine Ground Bones. Sent from Amherst, Mass.

	Pounds per Hundred.	
	1	2
Moisture, at 100° C.,	4.25	5.27
Total phosphoric acid,	24.06	23.18
Soluble phosphoric acid,	0.76	0.46
Reverted phosphoric acid,	3.66	3.62
Insoluble phosphoric acid,	19.64	19.05
Nitrogen,	2.88	3.73
Valuation per 2,000 lbs.,	$44 35	$46 82

"*Americo*," *A 1, Peruvian Guano.*

(Sent by Joseph C. Cozzen, Swansea, Mass.)

	Per cent.
Moisture, at 100° C.,	8.35
Total phosphoric acid,	10.03
Soluble phosphoric acid,	2.99
Reverted phosphoric acid,	1.72
Insoluble phosphoric acid,	5.32
Potassium oxide,	3.84
Nitrogen,	5.62

Valuation per two thousand pounds, $44.82.

PEAT.

1. Sent from Harwich, Barnstable Co., Mass.
2. Sent from Hudson, Worcester Co., Mass.
3. Sent from Holyoke, Hampden Co., Mass.

	Pounds per Hundred.		
	1	2	3
Moisture, at 100° C.,	78.26	33.61	54.28
Dry Matter,	21.74	66.39	45.72
Ash constituents in Dry Matter,	1.31	4.54	33.72
Nitrogen in wet Peat,	0.41	1.40	0.43
Nitrogen in perfectly dry Peat,	1.89	2.11	0.94

The difference in the composition of samples 1 and 2 is mainly due to their different state of moisture. Both are fair specimens of their kind. The low percentage of nitrogen in sample 3 is caused by an exceptionally large admixture of soil. Wherever the entire deposit shows a similar amount of earthy admixture, a direct cultivation, after draining, suggests itself as worth trying.

Crude Kieserit,

(Crude Sulphate of Magnesia. Of Bowker Fertilizer Co., Boston, Mass.)

	Per cent.
Moisture, at 100° C,	31.90
Calcium oxide,	2.60
Magnesium oxide,	13.50
Sulphuric acid,	29.10
Insoluble matter,	5.00
Magnesium in form of chloride,	0.60
Magnesium in form of sulphate,	38.70

Valuation per two thousand pounds, from $8 to $10.

The "Kieserit" occurs among the salines of the salt mines at Stassfurt in Germany, which of late have acquired a particular importance as leading resources of potash compounds for agricultural purposes. Although it forms distinct layers of considerable thickness, it is quite frequently found more or less saturated with a solution of magnesium chloride when removed from the mines. Well-established experimental observations regarding the injurious influences of the latter compound on the healthy growth of roots render its presence objectionable, and consequently its removal, as far as practicable, desirable, whenever kieserit shall be used for agricultural purposes.

The removal of any objectionable percentage of magnesium chloride is usually accomplished by subjecting the crude material to a moderate calcination. The moisture present largely decomposes, at a high temperature, the magnesium chloride into hydrochloric acid, which escapes, and into magnesium oxide, which remains behind. We find, for this reason, the calcined and uncalcined kieserit in our markets. The former contains, for obvious reasons, a larger percentage of magnesia than the latter; yet it is usually less soluble in water. Both kinds ought to be well ground to render a proper distribution possible.

The kieserit, on account of a greater solubility in water, exceeds in efficiency the sulphate of lime or gypsum, as an absorber of ammonia, in manure cellars, in stables, and upon the compost heap.

Its well-known beneficial influence on a speedy diffusion of potash compounds throughout a deeper layer of soil, as well as its reputed favorable action on leaf and stem growth, are of sufficient importance to encourage experiments on the part of farmers, and in particular of gardeners and fruit growers, to test its influence. The prominence of the magnesia among the mineral constituents of many of our grain crops and fruits, leaves scarcely a doubt about its importance in the vegetable economy of many of our cultivated plants.

Potash Magnesia Sulphate.

(Collected of Bowker Fertilizer Co., Boston, Mass.)

	Per cent.
Moisture, at 100° C.,	4.90
Calcium oxide,	1.15
Magnesium oxide,	11.30
Potassium oxide,	24.94
Sodium oxide,	2.09
Sulphuric acid,	46.99
Insoluble matter,	0.54

Valuation per two thousand pounds, $34.92.

The above compound belongs to a series of salines which some ten years ago, under the name of "German Potash Salts," or "Stassfurt Salines," were introduced into our agricultural industry for manurial purposes.

Its peculiarity consists in the combination of a large amount of potassium sulphate, from 46 to 47 per cent., with a remarkable quantity of magnesium sulphate, from 33 to 34 per cent.

The magnesium sulphate stands foremost among substances noted for their quality to counteract the well-known great retentive power of most soils for potassa.

This circumstance renders the potash-magnesia sulphate a very valuable material for the cultivation of deep-rooting plants, in case of an exhaustion of potassa in the subsoil.

The potash-magnesia sulphate, as well as the "Douglass Muriate of Potash," occupy a peculiar position among our

recently introduced potash resources for manurial purposes. The former has proved the preferable compound where the presence of large quantities of chlorides is known to affect seriously the quality of the vegetable growth, as in the case of tobacco, etc.; whilst the latter recommends itself, on account of from 70 to 75 per cent. of muriate of potash, in presence of from 15 to 20 per cent. of sulphate of magnesia, for deep-rooting forage plants.

A detailed discussion of the character and special fitness of the various brands of German potash plants for agricultural purposes can be found in the annual report of the Secretary of the Mass. State Board of Agriculture for 1874.

Dissolved Boneblack.

(Of Bowker Fertilizer Co., Boston, Mass.)

	Per cent.
Moisture, at 100° C.,	20.78
Total phosphoric acid,	15.66
Soluble phosphoric acid,	12.76
Insoluble phosphoric acid,	2.90

Valuation per two thousand pounds, $31.55.

Ashes from Detroit.

(Sent by John Lane, Esq., of East Bridgewater, Mass.)

	Per cent.
Moisture, at 100° C.,	6.39
Calcium oxide,	34.15
Potassium oxide,	1.00
Phosphoric acid,	2.05
Magnesium oxide,	3.72
Insoluble matter,	22.10

The ash had evidently been leached before it entered the market.

Turf.

(Sent on by Horace Graves, Amherst, Mass.)

1. Turf from upper layer, consisting largely of leaves, roots and mosses, — brown colored and fibrous.

2. Turf from lower layer, consisting of a brown peat-like mass, taken from four feet below the surface, and exposed to the air one year.

	1	2
Moisture, at 100° C.,	25.58	13.00
Organic and volatile matter,	96.72	90.57
Ash constituents,	3.28	9.43
Nitrogen (in wet peat),	1.91	1.97

The upper layer may be used advantageously as bedding and as an absorber of liquid manure; the lower layer ought to be composted with lime or ashes before it is incorporated in the soil. Both samples are of a good quality.

Ash of Bogs.

(Sent by J. B. Wheeler, Bolton, Mass.)

	Per cent.
Moisture, at 100° C.,	5.05
Calcium oxide,	3.09
Magnesium oxide,	1 13
Potassium oxide,	0.16
Phosphoric acid,	0.93
Insoluble matter,	70.92

The ashes were obtained from the burning of the surface growth of a swamp meadow lately in part underdrained. Bogs, tussocks, and a few inches thickness of the turf, furnished the ash. The dried-up condition of the vegetable matter explains the presence of but a small quantity of potash. The ash may prove beneficial upon adjoining grass lands.

Tobacco Stems.

(Sent by E. S. Warner, Hatfield, Mass.)

	Per cent.
Moisture, at 100° C.,	8.95
Dry matter,	91.05
Nitrogen in dry matter,	2.69

One hundred parts contained: —

	Per cent.
Potassium oxide,	6.21
Sodium oxide,	0.68
Calcium oxide,	4.76
Magnesium oxide,	1.14
Phosphoric acid,	0.87
Silica, sulphuric acid, etc.,	Not determined.

Valuation per ton of two thousand pounds: —

3.80 pounds nitrogen, at 18 cents,	$9 68
124.20 pounds potassium oxide, at 4¼ cents,	5 28
17.40 pounds phosphoric acid, at 6 cents,	1 04
	$16 00

The ash of the tobacco plant usually varies less in regard to absolute quantity than to the relative proportion of its essential elementary constituents. Potash is known to vary as high as 50 per cent. in consequence of modes of cultivation and variety of soil, independent of the variety of plant. As it is claimed by good authority that an increase or a decrease of the potash in the ash of the tobacco stands in a definite relation to certain qualities of the latter, it is proposed to discuss this question more in detail hereafter.

Superphosphate.

(Of Earle & Co., Providence, R. I. Sent from Dennisport, Mass.)

	Per cent.
Moisture, at 100° C.,	9.48
Total phosphoric acid,	15 08
Soluble phosphoric acid,	7.88
Reverted phosphoric acid,	0.69
Insoluble phosphoric acid,	6.51
Potassium oxide,	2.34
Nitrogen,	2.91

Valuation per two thousand pounds, $41.64.

Haynes Fertilizer.

(Of Mr. Haynes, Bolton, Mass. Sent from Lancaster, Mass.)

	Per cent.
Moisture, at 100° C.,	17.63
Total phosphoric acid,	10.14
Soluble phosphoric acid,	5.89
Reverted phosphoric acid,	0.87
Insoluble phosphoric acid,	3.38
Potassium oxide,	5.70
Nitrogen (organic),	2.72
Nitrogen (ammonia),	0.71
Nitrogen (nitrates),	0.60

Valuation per two thousand pounds, $41.85.

VI. Chemistry in Fruit Culture.

The subject of this discussion was the outgrowth of a series of field experiments with sugar beets upon the college farm (1870–75). The beneficial influence of certain articles of plant-food on the saccharine qualities and general character of the beet-root which had been noticed in that connection, suggested the extension of the observations to fruits.

The scarcity of systematic investigations concerning the mineral constituents of fruit-bearing plants and of fruits, rendered it necessary to ascertain their ash constituents under definite soil conditions, and to study the effect of special articles of plant-food on the mineral constituents of the growth produced by their aid. It was assumed that in case some definite change in the relative proportions of the mineral constituents was noticed, a safer basis could be obtained for distinguishing between the influence of season, location, the general character of the soil, etc., and the influence of the amount and the kind of the available plant-food applied. A portion of land in charge of the horticultural department of the Massachusetts Agricultural College has been set apart for that purpose since 1874.

Wild and cultivated varieties of grape-vines were the first plants chosen for the investigation.

The experiments have been extended in the course of time to strawberries, currants, blackberries, raspberries, apples, pears, cherries and peaches.

The results obtained with grape-vines and strawberries, which have been published in previous reports of the College (1875–76), in the reports of the State Board of Agriculture (1879–80), and in the Massachusetts Ploughman (1877–78), and elsewhere, have established the fact that fruit-bearing plants respond decidedly, as far as their composition is concerned, to the application of special manures.

The currants, raspberries and blackberries raised during the past year are at present under examination, and the fruits of most of the trees will be ready for examination a year or two hence.

The appended report of Prof. Maynard refers to the present condition of these experimental fruit plats, five in number. His statement regarding the serious influence of manuring peach trees in particular, without reference to wants, deserves attention.

VII. Peaches and Peach Yellows.

The interest manifested by frequent inquiries regarding the management of diseased peach trees on the College grounds, has to serve as an excuse for introducing the sub-

ject in the present report, although little that is new and of general interest can be added beyond the fact that the restored trees are healthy and bearing, and that new trees planted in the places where diseased trees have been removed,* have been bearing healthy fruit during the past season. The subsequent observations were made on peach trees planted in 1870 in the orchard of the College, and not on the young trees upon the experimental plats of the Station.

The experiments began in the fall of 1877, when my attention was first called to the appearance of the disease in the College orchard, on the top of a knoll of light soil. The general appearance of the trees at the first stage of the disease suggested to my mind the idea that an abnormal condition of the soil might be the first cause of its development. This circumstance could be due either to a more or less general exhaustion, or to the absence of only one or the other essential elements of plant-food; or finally, to the presence of some injurious substances which might have accumulated in the soil from some cause or other in the course of time.

The gradual disappearance of the green color (chlorophyl) in the leaves, beginning at the outer termination of the young branches, — which are the most active parts of the plants for the formation of new vegetable matter, — seemed to point towards a local interference with the normal cellular functions, a natural consequence of an abnormal sap. I felt inclined to consider the fungus which, in its gradual development, disfigures the diseased parts of the tree, a secondary cause of their ultimate condition. My observations of later years with grape-vines and currants in particular, have tended to confirm in my mind the view that our troubles with parasitic growth on plants are in many instances due to an abnormal condition of the soil, rather than to a particular condition of the atmosphere. I have repeatedly noticed that plants suffered seriously from mildew and blight upon unfertilized and exhausted lands, when upon adjoining fertilized plats neither could be noticed. Diseases of plants are known to originate from internal and external causes.

* See Prof. Maynard's appended Report.

Internal troubles may be increased by external influences and *vice versa*. As the gradual change of the new foliage of the affected trees from a bright green to a white or bleached appearance, had to be ascribed to a suppressed formation of the chlorophyl, my attention was quite naturally directed to earlier observations of a similar character. Some experiments by Nobbe, Schroeder and Erdmann (Chemnitz, 1871), had demonstrated the fact that the formation of the chlorophyl — the substance causing the green color of the plants — could be controlled by the application of certain forms of potassa, engaged my particular interest. Their observations were made on rye and buckwheat. They had raised both kinds of plants under well-defined circumstances, supplying to one set the potash in the form of sulphate of potassium, and the other in the form of chloride of potassium (muriate of potash).

The plants raised with the aid of the chloride of potassium were of a vigorous growth, with a rich dark-green colored foliage, and yielded a good crop of grain. Those raised by the aid of the sulphate of potassa turned prematurely yellow and failed gradually.

An examination of the diseased lots of plants showed an excessive accumulation of starch in the cellular tissue, whilst but little chlorophyl was noticed. On the strength of these considerations, I began a systematic investigation of the disease by an analytical chemical examination of various parts of the peach tree in different stages of growth. The results of these analyses are stated below in chronological order.

A limited number of trees affected by the yellows were also selected for the experiment with special manures. The ground around the trees was treated with superphosphates deficient in nitrogen (acid rock phosphate or soluble boneblack), and each tree (about eight years old) received from two to three pounds of muriate of potash, which was sown broadcast over a surface extending about eight feet from the trunk of the tree. None of these chemicals were brought into close contact with the trees, except when spread over a heavy mulch, to prevent serious reactions on the roots. The diseased branches were cut back at the same time to the healthy wood.

The practical management of these operations was, from the beginning to the present time, under the personal supervision of Prof. Maynard.

The application of phosphoric acid and of muriate of potash was repeated the succeeding spring. The new growth of branches and leaves showed a decided improvement both in vigor and color.

The trees have been cut back for several years, and they have since repeatedly produced healthy fruit.

Analyses of Parts of the Peach Tree.

Branches in Blossom from sound Crawford Peach Tree.

(Collected in May, 1877.)

Moisture lost at 100° C.,	56.77 to 59.74
Dry matter,	43.23 to 40.26
Ash in dry matter,	– to 4.63
Nitrogen in dry matter,	2.16 to 2.09

A.—Healthy Early York Peach.

(Nearly ripe, but not mellow. Collected August, 1877.)

Moisture lost at 100° C.,	86.61 to 88.00
Dry matter (entire fruit),	13.39 to 12.00
Dry matter in pulp,	10.94 to 10.98
Specific gravity of juice at 25° C.,	1.0375 to 1.04
Grape sugar in juice,	1.35 to 1.38
Cane sugar in juice,	4.12 to not det.

One hundred cubic cent. of juice neutralized from 40.5 to 44.0 cubic cent. of carbonate of soda solution (containing 1 part in 100).

B.—Healthy Early York Peach.

(Very ripe and mellow; tested three days after picking. Collected August, 1877.)

Lost in weight within three days,	5.48
Specific gravity of juice at 25° C.,	1.045
Grape sugar in juice,	1.92
Cane sugar in juice,	6.09

One hundred cubic cent. of juice neutralized 45 cubic cent. of soda solution (containing 1 part in 100). The whole weight of the peach tested was 49.32 grammes; stone weighed 3.71 grammes; ash of entire fruit, 0.2862, including carbonic acid.

*A.—Healthy Early Crawford Peach.**

(Nearly ripe, but not mellow. Collected September, 1877.)

Moisture lost at 100° C.,	88.120
Dry matter in pulp,	11.880
Specific gravity of juice at 22° C.,	1.045
Grape sugar in juice,	1.670
Cane sugar in juice,	5.920

One hundred cubic cent. of juice neutralized 64 cubic cent. standard soda solution.

B.—Healthy Early Crawford Peach.

(Nearly ripe, but not mellow. Collected in September, 1877, wrapped in paper, and kept in a drawer for ten days. It turned very ripe and mellow, and had lost 9.50 of its weight.)

Specific gravity of juice at 18° C.,	1.050
Grape sugar in juice,	2.19
Cane sugar in juice,	7.02

One hundred cubic cent. of juice neutralized 85.6 of soda solution.

C.—Healthy Early Crawford Peach.

(Picked from the tree when turning mellow, and tested without delay, September, 1877.)

Weight of entire fruit, ... 118.06 grammes.

	Per cent.
Moisture lost at 100° C.,	88.660
Dry matter in pulp,	11.360
Specific gravity of juice at 18 C.,	1.055
Grape sugar in juice,	1.700
Cane sugar in juice,	8.940
Total ash of entire fruit, including carbonic acid,	0.344

One hundred cubic cent. of juice neutralized 76 cubic cent. of soda solution.

Ash Analyses of Crawford's Early Peach.

(Entire fruit taken from healthy and diseased trees in the same orchard. To render the differences in composition more prominent, only carefully determined constituents are reported, excluding soda, silica, etc., from the calculation.)

	Healthy Fruit. Crawford's Early Peach.	Diseased Fruit. Crawford's Early Peach.
Ferric oxide,	0.58 per ct.	0.46 per ct.
Calcium oxide (lime),	2.64 "	4.68 "
Magnesium oxide,	6.29 "	5.49 "
Phosphoric acid,	16.03 "	18.07 "
Potassium oxide,	74.46 "	71.30 "
	100.00 "	100.00 "

* All samples tested taken from the same tree.

Although the disease was in its first stage, the results show a marked difference in regard to the relative proportion of the mineral constituents of the healthy fruit, as compared with that from the diseased tree or the prematurely ripened fruit. These results seemed to prove the correctness of my views regarding the first cause of the disease.

Feeling, however, not satisfied with an explanation based on a presumed analogy of circumstances, I invited Prof. Penhallow, in the fall of 1880, to join me in the investigation by making some microscopic observations for the purpose of establishing, if possible, more clearly the relation of the fungus to the disease.

The questions proposed to him may be summed up as follows: —

1. Is there any abnormal accumulation of starch in the diseased wood, as compared with a healthy wood? 2. Does the wood of the restored tree regain again the general appearance of that of the healthy tree? 3. What becomes of the fungus in case of a diseased tree being restored to health? These questions were to be answered by an examination of a lot of branches taken from healthy, diseased and to-health-restored trees. The three samples of branches of the peach trees, from which the previously stated specimens for microscopic observation had been selected, were each carefully examined, and the ashes subjected to a careful analysis. The branches were secured in the presence of Prof. Penhallow, Nov. 11, 1881.

Their analysis was carried on by me, and repeated under my immediate supervision by an efficient assistant.

I. Analysis of the ashes obtained from the branches of a diseased Early Crawford Peach tree.

Ferric oxide,	1.44590
Calcium oxide,	64.22920
Magnesium oxide,	10.28270
Potassium oxide,	15.67516
Phosphoric acid,	8.36690

II. Analysis of the ashes obtained from the branches of a peach tree which had been affected in previous years by the yellows, and had been restored again to health in consequence of the treatment described in preceding pages.

Ferric oxide,	0.5213
Calcium oxide,	54.5136
Magnesium oxide,	7.5788
Potassium oxide,	26.0129
Phosphoric acid,	11.3732

The differences in the composition of Ashes I. and II. are in the same direction as noticed in the ashes of healthy and diseased fruits, of the same variety of peaches.

Prof. Penhallow's microscopic observations are stated by him in the following summary: —

1. Healthy wood shows comparatively little stored starch; but fungous growth is present in the outer layers of the bark.

2. Diseased wood shows an abnormally small development of the cells, and the invariable presence of large quantities of starch; also an abundance of fungous growth.

3. Diseased leaves show the presence of fungous growth, discoloration and cells filled with starch.

4. The fungus appears first on the surface of the trunk or branches, and thence enters the woody structure, when the conditions are favorable.

5. There is little or no difference between the tissues and cell contents before and after the leaves fall.

6. While fungus is abundant on fully diseased trees, it is also to be found on trees which, *once diseased, had been restored to a condition of vigorous health.**

These results apparently confirm the views entertained when planning the investigation, and tend to show that an interior disorder, caused by an abnormal composition of the sap — as far as its mineral constituents are concerned — precedes the serious development of the fungus.

Our late advice to fruit-growers has been based on the teachings of the experiments previously described.

We recommend a careful watching of the peach orchard, to notice the disease in its first stages if possible.

The first signs are to be met by an immediate application of from two to three pounds of muriate of potash to each

* More detailed investigations of Prof. Penhallow have been recently published by him, in connection with the publications of Houghton Farm.

tree, within a radius of from six to eight feet from the trunk. This dressing is best applied upon a heavy mulch of grass or cut straw. The cutting back of the diseased branches to the healthy wood ought to be carried out as general considerations recommend. A repetition of the same treatment for one or two seasons has been usually sufficient to correct the new growth of the tree, provided the disease has not gone too far before the remedies were applied.

Besides the special treatment of the affected tree — as previously described — we have recommended as a general fertilizer for a peach orchard the following composition, which has served us well in past years: Broadcast per acre 400 to 450 lbs. acid bone phosphate, containing from 11 to 12 per cent. of soluble phosphoric acid; 125 to 150 lbs. of muriate of potash, and 75 to 100 lbs. of crude sulphate of magnesia (Kieserit).

The latter compound is added for the purpose of assisting in the diffusion of the potash, and securing available magnesia.

This fertilizer is best applied partly late in the fall and partly in the early succeeding spring. The fertilizer ought to be applied with a view to supply existing wants, rather than to promote excessive growth of wood.

C. A. GOESSMANN,
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Assistants —

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